THE

AMERICAN
JOURNAL OF PSYCHOLOGY

EDITED BY

G. STANLEY HALL,

E. C. SANFORD, Clark University. AND E. B. TITCHENER, Cornell University.

WITH THE CO-OPERATION OF

F. ANGELL, Stanford University; H. BEAUNIS, Universities of Nancy and Paris; I. M. BENTLEY, Cornell University; A. F. CHAMBERLAIN, Clark University; C. F. HODGE, Clark University; A. KIRSCHMANN, University of Toronto; O. KUELPE, University of Würzburg; W. B. PILLSBURY, University of Michigan; A. D. WALLER, University of London; M. F. WASHBURN, Vassar College.

VOL. XV.

CLARK UNIVERSITY, WORCESTER, MASS.
LOUIS N. WILSON, Publisher.

1904.

COMMONWEALTH PRESS,
OLIVER B. WOOD, PROPRIETOR,
WORCESTER, MASS.

TABLE OF CONTENTS.

BENJAMIN RICHARD ANDREWS,
Auditory Tests, ... 14-56

L. D. ARNETT,
The Soul—A Study of Past and Present Beliefs, 121-200; 347-382

I. MADISON BENTLEY,
Professor Cattell's Statistics of American Psychologists, 102-103

I. M. BENTLEY AND E. B. TITCHENER,
Ebbinghaus' Explanation of Beats, ... 62-71

GIOVANNI CHIABRA,
The Tendencies of Experimental Psychology in Italy, . 515-525

C. E. GALLOWAY,
The Effect of Stimuli upon the Length of Traube-Hering Waves, ... 499-512

ROBERT H. GAULT,
A Sketch of the History of Reflex Action in the Latter Half of the Nineteenth Century, ... 526-568

BERTHA KILLEN,
The Effects of Closing the Eyes upon the Fluctuations of the Attention, ... 512-514

F. KUHLMANN,
Experimental Studies in Mental Deficiency: Three Cases of Imbecility (Mongolian) and Six Cases of Feeble-Mindedness, ... 391-446

ROBERT MACDOUGALL,
Facial Vision: A Supplementary Report, with Criticisms, 383-390

W. P. MONTAGUE,
A Theory of Time-Perception, ... 1-13

W. B. PILLSBURY,
Studies from the Psychological Laboratory of the University of Michigan, ... 499-514

JAMES P. PORTER,
A Preliminary Study of the Psychology of the English Sparrow, ... 313-346

THEODATE L. SMITH,
The Psychology of Day Dreams, ... 465-488

C. SPEARMAN,
The Proof and Measurement of Association between Two Things, ... 72-101
"General Intelligence," Objectively Determined and Measured, ... 201-293

GUSTAV SPILLER,
The Problem of the Emotions, ... 569-580

H. C. STEVENS,
A Simple Complication Pendulum for Qualitative Work, 581

E. B. TITCHENER,
Some New Apparatus, ... 57-61

E. B. TITCHENER and I. M. BENTLEY,
Ebbinghaus' Explanation of Beats, ... 62-71

GUY MONTROSE WHIPPLE,
Reaction-Times as a Test of Mental Ability, . . 489-498

ANONYMOUS,
Nocturnal Emissions, ... 104-107

ERRATA, ... 120

LITERATURE, ... 108-120; 294-312; 447-462; 582-596

NOTES, ... 312; 463-464

THE AMERICAN
JOURNAL OF PSYCHOLOGY

Founded by G. STANLEY HALL in 1887.

VOL. XV. JANUARY, 1904. No. 1.

A THEORY OF TIME-PERCEPTION.

By W. P. MONTAGUE, Columbia University.

I.

THE SPECIOUS PRESENT.

The first question to be faced in a study of time-perception is the question of the "specious present;" for without the consciousness of an extended segment, or period, of past time it would be impossible to perceive either duration or succession. This problem of the specious present is not only the most important,—it is also the most perplexing of the many problems of our time consciousness. It is a case in which sense-perception presents as an actuality what Reason must regard as an impossibility. The present of metaphysical or conceptual time is a point, separating past and future; the present of psychological time—the specious present—is a continuous segment extending appreciably into the past. We cannot hope to solve this antinomy by violating Reason; we must not accept the presence of what is no longer present as a reality. Sense must be subordinated to Reason, and the specious present must be regarded as specious, as an illusion which is somehow explicable on the assumption that the real present is a point. The problem may then be stated as follows:

How is it that at any one moment there can appear to be present several moments?

II.

THE MEASUREMENT OF TIME.

Time is the form of change, and the amount of change is the measure of the time which is perceived to have elapsed during the change, precisely as the size of a body is the measure of the

space actually or possibly filled by the body.[1] Taken in abstraction from all content, space and time, if not nothing, are at least quite without determinate form and size. As space and time are measured by what fills them, so, too, is the concrete filling measured by comparison with other concrete filling. A body is large or small according to the smallness or largeness of a second body selected as standard of measure. A change is great or small according to its relation to some other change which we take as a basis of comparison. Magnitude, whether conceptual or perceptual, is intrinsically relative.

III.

The Subjective and Objective Aspects of a Psychosis.

Every psychosis has two distinguishable but inseparable aspects, the subjective and the objective. The subjective element or "knowing thought" is the whole system of conscious contents taken collectively and including the incoming content, while the latter is the *object* of the (normally prospective) act of attention. A content is perceived as an object only in so far as it is projected upon a subjective background of pre-existing states. In Herbartian terms, we may describe every psychosis as the assimilation of an entering sensation-mass by a receiving apperception-mass.

I believe that the solution of the problem of the specious present depends on our realizing that the subjective and objective elements of a psychosis possess differing rates of change.

What is sometimes called the Law of Relativity is an expression of the fact that in consciousness every content is determined not only by its stimulus, but also by every other content. A change in one state is necessarily attended by a change in the other states, both individually and collectively. If we are right in regarding the knowing thought or subjective aspect

[1] It might be objected that the experience of unequal amounts of change occurring in equal times is in flat contradiction to the statement that time is measured by its contents. When, however, we seek for the grounds on which the two unequally filled times are judged equal, we see that their estimated equality arises from our comparing them, not with an absolute time, but with other changes of content, either those of our subjective consciousness or those of a third object, such as a clock. That absolute or empty time does not enter as a factor into the perceptual estimate of time is further shown by the fact that when equal time-intervals containing unequal quantities of change are perceived separately and without relation to a third object, they are, as a matter of fact, felt to be unequal. And the estimated inequality of their times is in proportion to the perceived inequality of their contents. Notwithstanding the uselessness of absolute time as a standard of perceptual measurement, the idea has a certain validity. The absolute clock is the totality of things, viewed as a single system.

of a psychosis as the totality of existing states, considered as forming a system having a single structure, or configuration, it will be clear that the changes induced in the form of that totality by a change in one of its parts will usually be less than the change in that part. In a word, a change in one conscious state produces a change (though a less change) in the system of states; and other things equal, the larger the apperception-mass, the smaller the changes produced in it by the changes in any one of its sensory aspects. The perception of a change is a changing perception, but a perception that changes less rapidly than the change that is perceived.

It cannot be too strongly emphasized in this connection that the increment of change produced in a conscious state,—or apperceptive system of states,—while it varies directly with the stimulus causing it, also varies inversely with the content in which it is caused. Thus if s be a conscious state and Δs be its increment of change, Δs will be large in proportion as s is small. In this respect, and, so far as I can see in this respect only, do increments of *change* differ from the increments of *substance*, ordinarily considered in the calculus.

There is a second point to which I would especially call the reader's attention before proceeding further. I have spoken, and shall speak throughout, of conscious states as quantities, expressible by quantitative symbols, and subject to quantitative laws: yet, nevertheless, these quantitative expressions can be, *and perhaps should be*, interpreted as applying to the *physiological concomitants* of conscious states. The reader who is sensitive on this subject can substitute the physical for the psychical interpretation of the quantitative symbols, without changing the meaning of the argument at any point

Let Δo symbolize the amount of change or alteration in the objective content o produced in any period of time Δt, and let Δs symbolize the resulting change produced in the subjective aspect of consciousness during the same time. Then $\frac{\Delta o}{\Delta s}$ will represent a change in the objective as compared with the change in the subjective element in the time Δt. As Δt is made to decrease without limit, Δo and Δs will correspondingly decrease, but the fraction $\frac{\Delta o}{\Delta s}$ will not necessarily decrease, but will either approach, or if the rate of change be uniform, will maintain the finite value $\frac{do}{ds}$. Now this derivative of the objective change with regard to the change of the subjective element is a finite quantity, but one that is realized at each infinitesimal moment of time. If we were right in affirming in the preceding section that perceptual space and time magnitudes are essentially

relative matters, determined not by the "absolute" size of the magnitude to be measured but by the ratio of that magnitude to the unit of measure, it will be evident that the amount of objective time or change which appears to be present at any one moment will be measured by its ratio to the subjective change which accompanies it. And if the subjective unit of measure be infinitesimal, the objective change-magnitude may be also infinitesimal and yet may *appear* finite. In short the infinitesimal time-change which occurs at the unextended metaphysical present will be appreciated as an extended psychological present, provided it be measured in terms of an infinitesimal of different order.

That Δs, the change in the subjective totality of conscious contents, is less or "slower" than Δo, the change in that phase of the totality selected as object by the act of attention, has been shown: consequently the symbol $\frac{do}{ds} = \lim\limits_{\Delta t = o} \left[\frac{\Delta o}{\Delta s}\right] > 1$ may be accepted as properly representative of the "specious" or "extended" present; *and the latter is from this point of view seen to be compatible with the real or metaphysical present of conceptual time.*

IV.

Duration and Succession.

At the outset of our discussion it was stated that the perception of the specious present was prerequisite to the perception of duration and succession. Now introspection assures us that the specious present never maintains the same value from moment to moment. It is always either expanding or contracting. *But an increase in the specious present means an increase in the period of past time which appears at present, that is to say an increase in the time during which the events filling it have been perceived.* The objects or events, therefore, which occupy the expanding specious present are felt as "enduring," while conversely those that fill the contracting specious present are felt as "passing" or "succeeding." This alternate increase and decrease of $\frac{do}{ds}$ implies of course a corresponding alternation in the sign of the second derivative. When an object o is perceived as enduring, $\frac{d^2o}{ds^2}$ is positive; at the moment when o is succeeded and displaced in consciousness by some other object, $\frac{d^2o}{ds^2}$ is negative.

V.

"Time Dragging" and "Time Flying."

The second derivative of the objective with regard to the

subjective change not only indicates by its *sign* the enduring or passing phase of its contents, but by its *magnitude* it marks the *seeming rate of the time-flow itself.* A small or large change-rate (whether increasive or decreasive) in $\frac{do}{ds}$ means a correspondingly small or large value of $\frac{d^2o}{ds^2}$. In view of the fact previously mentioned that $\frac{s}{o}$ varies as $\frac{do}{ds}$, it is interesting to note that, as might be expected, the first and second derivatives also vary inversely. The longer an event endures, *i. e.*, the greater the value of $\frac{do}{ds}$, the less the rate of its change, and the less the value of $\frac{d^2o}{ds^2}$. The further past an event seems, the more slowly does it appear to increase in pastness, while conversely, the events of the present are those which seem to fly by most rapidly.

This would seem to afford a clue to the curious alterations which we experience in the *rate* of time-flow. For it is obvious that when new objects continuously distract the attention, the specious present is constantly being destroyed and made anew; and, as we saw, this enforced smallness of $\frac{do}{ds}$ would mean a correspondingly large value of $\frac{d^2o}{ds^2}$. The seeming rate of the time-flow is great in proportion to the number of new distractions. And conversely when the mind is without internal or external distractions, when there is nothing to think about and nothing to do, the specious present with its single content of *ennui, i. e.*, the consciousness merely of being conscious, grows to an enormous size with a consequent decrease in $\frac{d^2o}{ds^2}$, a decrease, that is to say, in the apparent rate of the time-flow. Time here is felt to *drag* as in the presence of distraction it is felt to *fly*.

VI.

The Rhythmic Character of Consciousness.

We have only to reflect upon the nature of the specious present as already described to understand the intrinsically rhythmic character of consciousness.

Let us suppose a mind to experience a series of sensations o_1, o_2, o_3, o_4, in moments t_1, t_2, t_3, t_4. The specious present at t_2 has a duration of two moments and contains the image-trace of o_1, and also the sensation o_2; and the specious present at t_3 has a duration of three moments and contains in addition to the sensation o_3, the images of o_1 and o_2. From the persistence of images the specious present tends to increase not only in "length" but in contents. This increase is not in a finite consciousness unlimited, but depends upon the degree to

which the accumulating contents are harmonized in a single meaning.

In consciousness as we know it, each content is to some degree a *rival* of its fellows. Of course it is also true that different contents to some extent support and enhance one another, and the law (first formulated, I believe, by Fechner) that the intensity of attention varies inversely as its extent is only a half truth. That is to say, it is only true for psychoses in which the "competition" of contents tends to become stronger than their "co-operation." The law is in general, however, rather more true than false, because as the number of elements in a system increases, co-operation becomes less easy and antagonism less difficult. And as the sweetest toned instrument will, if too loudly or too variously excited, reach a point at which the dissonance of the over-tones will exceed their harmony, so with the specious present there inevitably comes a time when the manifoldness of its contents makes their unity no longer capable of transcending their variety.[1]

Returning to our example we will suppose that in the mind which has experienced o_1, o_2, and o_3, the specious present has reached the critical point at which the further dispersal of attention demanded by a new content will result in its dissolution. The new content o_4 enters; the specious present ceases its slow expansion and begins rapidly to contract. The images of o_1, o_2 and o_3 crumble away and the attention thus liberated is caught by the strongest bidder which, in our case, is the present sensation o_4. On this as foundation a new specious present is rapidly built up, containing as a halo or "fringe" the shade of its parent. It is important to bear in mind the fact that the manner in which our specious presents are destroyed is different from the manner in which they are rebuilt. The old contents do not flow out as the new contents flow in. The events which are born singly die in cycles.

A rhythmic series of experiences affects us strongly and holds our attention because its objectively recurring periods harmonize with the subjectively recurring contractions and expansions of the specious present, each series being thus reinforced by the other. Subjectively viewed, the rhythmic character of consciousness is due, as we have seen, to the fact that each specious present contains in addition to the birth-seeds of new presents the seed of its own decay. Like other live things our time-

[1] Professor Loeb (*Comparative Physiology of the Brain*, Ch. XIX) holds that the intensity of a mental state is diminished by the simultaneous presence of other states, when and only when the underlying physiological processes are *aperiodic*. Simultaneous periodic processes so far from diminishing may actually enhance each others' intensity.

consciousness is rhythmic, because like them it is born with the canker of death at its heart.

VII.

Memory.

So far we have been dealing with the immediate apprehension of the just past. We have now to discuss the bearing of the theory upon the consciousness of the more remote past. Memory proper, or recall, is differentiated from the consciousness of the just past, by the fact that in the latter the event has been continuously present to consciousness since the time of its occurrence, while in recall, as the word indicates, the event remembered has been absent from consciousness between the time of its occurrence and the time of its recurrence. Every case of memory is thus a case of recurrence, but every case of recurrence is not a case of memory. In addition to the fact of recurrence there must be a recognition of recurrence, a recognition that something is being experienced *again*. The mere fact of recurrence is not difficult to understand. If the physiological ground or concomitant of an experience leaves as a trace of itself a specific modification of the brain structure— a "path," for example,—it is natural that when that particular part of the brain is re-excited, whether by stimulus or from within, we should re-experience the content. The really curious thing about memory is not the recurrence but the recognition of the recurrence; the consciousness of having experienced the *same* content at a more or less definitely localized moment of the past. Now we have seen that within the scope of a single specious present the amount of time which has elapsed since the occurrence of an event is measured by the ratio of its change-rate to the change-rate induced by it in the apperceptive system upon which it is "projected." This apperceptive system or apperception-mass is (when the attitude of attention is retrospective) nothing but the collective totality of contents which have been perceived since the event in question first appeared. And the change-rate of such a system is inversely proportional to its size. The specious present, then, increases with the increase of the apperception-mass, and hence the extent of the latter suffices to measure not only the duration of time from a point in the past up to the present, but conversely, the felt distance of that point from the present, *i. e.*, its date. Thus when the specious present is large, the date of its earlier events is felt to be remote, while, conversely, the earlier events of a small specious present are felt to be of recent date.

I believe that the date of a remembered object is measured in the same way. The specifically modified brain-cell, when

re-excited, excites in its turn the physiological traces of the experiences intervening between its first occurrence and the present moment, with the result that these intervening experiences vaguely and very schematically recur as an apperception-mass for the recurrence of the content which suggested them. And precisely as in the case of the specious present, the rate of change in this apperceptive system is, in proportion to its extent, small as compared with the change in the single content. The ratio of the latter to the former—$\frac{do}{ds}$—measures and represents the date, *i. e.*, the period of time that appears to have elapsed since the event first occurred. But the remembered event is not only projected upon this large and schematic apperception-mass: it is, together with the latter, projected also upon the background of concrete experiences which fill the regular specious present of the moment. Thus it appears to us in *two* contexts or aspects—as a present event in our mental life and as an event of the past. The *againness* of the remembered event is due precisely to this duality of its apperceiving system.

The view that the date or temporal sign of a remembered happening is determined by the recurrence of the intervening experiences is borne out by the recognized facts of the memory consciousness. For, in the first place, we can recall the date of an event only when we have some memory of what has followed it. (By date I mean of course the *felt* date, not the date as abstractly known.) When the intervening experiences are numerous and interesting, the apperceptive system s, in which they schematically recur, is large, and the differential fraction $\frac{do}{ds}$, which measures the lapse of time since the occurrence of o, is also large. While, conversely, when few experiences have intervened between an event and our memory of it, the apperception-mass is small and the date appears more recent than it is.[1] Finally, when the activity of the perceptive faculty is completely suspended, as in trance or change of personality, and when consequently there are no intervening experiences out of which to make a memory apperception-mass, we find, as our view would lead us to expect, no appreciation of the period of time separating the remembered event from the moment at which it is remembered. In such cases, the events of months ago are regarded as those of yesterday.

In spite of the "concomitant variation" of the number of intervening experiences and the distance of the assigned date of the remembered event, it may still seem that we have not sufficiently explained the profound difference between memory of

[1] The rate of time-flow is, as we know, reversed in retrospect. Periods that felt brief when passing are remembered as long, and *vice versa*.

the remote past and immediate consciousness of the just past. In order to remove any such misgivings, let us sum up the points of difference already noted between the two kinds of consciousness of the past. In the first place, in immediate apprehension the apperception-mass is the concrete complex of experiences which having just occurred have not yet faded from consciousness. In memory, on the other hand, the principal apperception-mass is a vast, hazy, highly schematic group of contents, the merest skeleton of the experiences of the intervening period. And secondly, in addition to this contrast in the backgrounds upon which the two kinds of past are respectively projected, there is a single background in the case of immediate apprehension, while in memory there is a double background,—the schematic system just mentioned, and the concrete system of contents which makes up the specious present of the moment in which the act of memory takes place. And to this duality of apperceptive context is due, as we have seen, the feeling of "againness" or recurrence which is distinctive of the memory psychosis.

VIII.

Familiarity.

The feeling of familiarity, which is akin to memory, differs from recall proper in two ways. In the first place the event recognized as *familiar* is normally caused by an external stimulus, and hence possesses the vividness and arbitrary "givenness" characteristic of a sensation as distinguished from an image. And in the second place, the memory apperception-mass is so entirely subordinated to the specious present in which the familiar sensation occurs that it serves merely to give to the latter a fringe of pastness in which there is no appreciable indication of date. In short the feeling of familiarity is the apprehension of a present event with a fringe of pastness, or "recurringness," while in the memory judgment, the recognition of a more or less definitely dated past is primary, and is only secondarily qualified by a fringe of presentness due to the act of memory itself.

IX.

The Conditions under which Time Perception Originates.

When we inquire how a specious present begins or how it can apply to a single sensation, we are confronted by a peculiar difficulty. According to our view there must always be a pre-existing background of mental states upon which the content perceived as an object is projected. But in the first

moment of a psychosis, or in the case of a single sensation, this would seem impossible. And yet when we are awakened from a state of unconsciousness by a touch or a sound, we do not experience a sensation that is without duration. If anything, the time-form is more noticeable in the simple and approximately sensational first stage of an experience than in the later and more complex stages. The *meaning* of a sensory content is felt only when we feel its relation to other contents: but not so with its duration. As soon as it is perceived, or rather, in order that it may be perceived, we must be conscious of it as enduring. Our problem is to point out what it is that plays the part of apperception-mass in the case of a single sensation and at the first moment of an experience.

Let us begin by considering the case of a possible single sensation which has established itself in consciousness. Along with the sensation at any moment will be the consciousness of it as it was in the just preceding moments. Let o_4 represent the sensation at the fourth second of its existence, and o'_1, o'_2 and o'_3 symbolize the present image-traces of its earlier existence. It will be sensed in the light of these image-traces precisely as an incoming element in a complex pyschosis is apperceived by the other elements. The "apperceptive system" for a single sensation—if such were possible—would then be nothing but the image-traces of its just-past existence. And the specious present, $\frac{do}{ds}$, of such a sensation would be expressed (at the fourth second) by the symbol $\frac{do_4}{d\,(o'_1\ o'_2\ o'_3)}$. When the apperceptive system or subjective background, composed of the image-traces $o'_1\ o'_2\ o'_3$, became greater, or more prominent for consciousness than the present sensation o_4, the rate of change of the former would become less than that of the latter, *i. e.*, $\frac{do_4}{d\,(o'_1\ o'_2\ o'_3)} > 1$—and a specious present or perceptual time-form would be realized.

So much for the time-form of a single sensation after its origin. Can we make use of this account to explain the *simultaneous* origin of an experience and its time-form? Here as elsewhere, in explaining the origin of anything in consciousness, we are compelled to fall back upon those physiological processes which are the secondary, or it may be the proximate conditions of sensory states. When by the action of a specific stimulus an equally specific disturbance in the cortex is produced, the latter does not, we may suppose, die out the instant the stimulus ceases, but continues for a short time, as the violin string continues to vibrate after the bow has been withdrawn. If the same stimulus be applied again the resulting disturbance will be a complex of the pre-existing disturbance and the re-

newed effect of the stimulus. Now if the stimulus act in such a manner that the disturbance in the brain-center due to past action become greater than the effect of its present action, *there will be produced on the physiological level a perfect counterpart of the psychological conditions of the specious present.* That is, we shall have a "subjective" or pre-existing state of disturbance greater or more vigorous than the incoming impulse. The modification in the nerve center due to the just past will dominate that due to the present. If under these conditions a sensation arise, it will arise with a time form. Let us suppose a case in which a stimulus must act continuously for four seconds in order that a sensation may arise. We may represent the resulting disturbances of the central organ by $o(-_4)$, $o(-_3)$, $o(-_2)$, $o(-_1)$, and their traces by the same symbols primed. We may suppose that at the moment when the sensation o_1 arises, the physiological stimulus-traces $o'(-_4)$ $o'(-_3)$ and $o'(-_2)$ are together equal in intensity to the impulse $o(-_1)$, and that when increased by the trace of the latter the pre-existing state will dominate the incoming state,—which, if it be felt at all, will be felt in a time-form or specious present represented by $\overset{do}{\overrightarrow{d\,(o^1_{(-4)}\quad o^1_{(-3)}\quad o^1_{(-2)}\quad o^1_{(-1)})}}\ t.$

Now inasmuch as every sensation which we can imagine ourselves to experience has a time-form, we must conclude that in defining the conditions of the origin of a specious present we have at the same time defined one of the essential conditions for the origin of conscious states in general.

The several steps in our argument may be summed up as follows:

I. The central fact of time-consciousness is the "specious present"—the present consciousness of what is no longer present. Without this apparent projection of past moments upon each present moment, there could be no consciousness of either duration or succession.

II. Time is the form of change; and change, like every magnitude, is relative to its unit of measure. The amount of perceived change in an object is relative to the actual concomitant change in the perceiving subject.

III. Regarding the 'object' as simply the objective aspect, and the 'subject' as the subjective aspect of a psychosis, we may hold that each incoming objective content is apperceived by or projected upon the entire system of pre-existing states. The psychosis considered only in its collective unity is subjective; considered only in its distributive plurality, it is an aggregate of objects; considered (as it must be) under both aspects simultaneously, it is a "subject-perceiving-objects." As the apperceptive system is larger than any of its objective contents,

the constant stream of increments and decrements produces in the latter changes that are proportionately greater or faster than the change that they in turn cause in the system as a whole. *This difference in the rates of an objective change and the subjective change which reflects it, measures the amount of perceived change and perceived time.* And though Δs and Δo (the actual subjective and objective changes respectively produced in s and o by the environmental increment of content) would approach zero as Δt approached zero, yet the ratio $\frac{\Delta o}{\Delta s}$ would approach or maintain the finite value $\frac{do}{ds}$. And this for the same reason that the velocity of a moving body, if uniform, maintains, and if accelerated, approaches, a finite value, when the space through which and the time in which it moves approach zero. By assuming the amount of perceived time to be a continuously present *differential rate*, it becomes possible to reconcile the "specious," "vicarious," or "perceptual" presence of an extended segment of the past with the real or unextended present. Finite positive portions of time and change are perceived as present when $\frac{s}{o}$, and consequently, $\frac{do}{ds}$ are greater than unity.

IV. Time is felt as *enduring* when $\frac{do}{ds}$ is increasing in value; *i. e.*, when $\frac{d^2o}{ds^2}$ is positive; and conversely, when the second derivative is negative, the events are felt as escaping or *passing*.

V. As the positive and negative *signs* of the second derivative respectively denote the enduring and the passing phases of perceptual time, so the *value* of the same ratio measures the perceived *rate* of time. Time "flies" or "drags" according as $\frac{d^2o}{ds^2}$ is large or small. And as in this case the first and second derivatives vary inversely—*i. e.*, the longer the time-span or specious present the slower its rate of change—it follows that the events that are near to the present appear to *acquire pastness* more rapidly than those further past. (This I take to be the explanation of the apparent conformity of time-perception to Weber's Law.)

VI. A specious present tends constantly to increase, but this naturally cumulative tendency brings about automatically in every finite consciousness a counter-tendency; for in so far as the contents of a psychosis are not perceived in the light of a single plan, the degree to which each is attended to is inversely proportional to the number of all; and there comes a time when the content of longest duration can no longer hold the attention.[1]

[1]There are two fundamentally distinct features of a content that attract the attention—its intrinsic intensity and its extrinsic bearing upon other contents. The latter is the conceptual or unifying factor and is usually possessed in the greatest degree by the content of longest duration, because it is the center in relation to which the rest of the

That activity on being thus torn from its attachment to the keystone of the system, by the dissipative force of numbers, is for the moment open to the highest bidder, which is usually the most recent sensation; and about this as a center a new present is built up. This alternation of slow accumulation and rapid crumbling, in the time-span, throws light alike upon the rhythmic character of consciousness and upon the pleasurableness of objective rhythm.

VII. Memory differs from the immediate consciousness of the past in two ways. In the first place the remembered event (*i. e.*, the re-excited trace of the past experience) is projected upon a schematic and hazy apperception-mass, composed of traces of a few of the more important intervening experiences. This makes possible the felt date, while it enables us also to account for the indefiniteness and inaccuracy of it. In the second place the remembered event is less noticeably projected upon the concrete apperception-mass of the specious present in which the act of memory takes place. It is thus seen in two contexts, and to this duality of background its "againness" may be ascribed.

VIII. The feeling of familiarity differs from memory proper, in that the trace of the past event is excited sensorily from without, and is projected primarily upon the specious present of the moment, and only secondarily upon the background of intervening experiences. It is an experience of the present with a fringe of the past, while memory is an experience of the past with a fringe of the present.

IX. The manner in which a time-form can apply to a single sensation, and the manner which it can originate at all, present peculiar difficulties. Confining our attention to a possible single sensation, we find that in such a case the apperceiving background for the sensation, after its origin, would be composed of the image-traces of the sensation itself. The formula for the specious present becomes $\frac{do}{do^1}$ where o^1 represents the pre-existing subjective traces due to the presence of the sensation in the preceding moments. But these quantitative symbols may with equal or, as some psychologists would hold, with greater propriety be used to denote the physiological concomitants of sensation. And the symbol $\frac{do}{do^1}$, when taken physiologically, may represent a condition just *antecedent* to perception. From this point of view we can understand how it is that the time-form of a psychosis arises simultaneously with its contents.

---

system is interpreted. On the other hand the intensive or sensory factor is peculiarly the property of the sensation of the moment—and it is the gradual but inevitable gain of the latter or centrifugal over the former or centripetal factor, that brings about the periodic dissolution of each psychosis.

AUDITORY TESTS.[1]

BENJAMIN RICHARD ANDREWS, A. B., A. M.

TABLE OF CONTENTS.

		PAGE.
Introduction.		14
Chapter I.	Mental Tests and Their Relation to Psychology and Pathology	15
Chapter II.	Literature of Mental Tests	20
Chapter III.	Tests of Acuity of Hearing	26
	A. Speech Tests of Acuity	26
	B. Tests with Mechanical Sounds	42
	I. Tests of Acuity with	
	Watch	42
	Acoumeter	44
	Audiometer and Electrical Devices	45
	Forks	46
	II. Tests of Tonal Limits	46
	Lower Limit	46
	Upper Limit	48
	C. Appendix to Chapter III.	49

INTRODUCTION.

The two great functions of the ear are these: it furnishes the most common means of intercommunication, that of spoken speech; and it opens to mankind one whole department of the fine arts, that of music.

Efficient hearing is indispensable if the individual is to do his full part in the world's work, or to enjoy his share of its æsthetic pleasures. Normal functioning of the auditory organs is, therefore, a matter of importance to the individual. This paper discusses tests which may be applied to an individual to determine his auditory capacity as normal or abnormal. Such tests form part of what are commonly called "mental tests," *i. e.*, tests which have to do with mental factors. Our subject has, therefore, a certain relation to psychology. Moreover, since certain auditory tests are used to diagnose aural disease, it has also a relation to pathology.

The first chapter contains an examination of the concept of "mental tests," and of the relation of such tests to psychology and pathology. In the second chapter, the literature of mental tests is briefly reviewed. These two chapters serve as a pref-

[1] From the Psychological Laboratory of Cornell University.

ace to the description of the various auditory tests, which forms the main problem of the paper. These tests are treated in three divisions, forming chapters three, four and five: Chapter III: Tests of auditory acuity (a) with spoken words and (b) with mechanical sounds; Chapter IV: Tests of musical capacity; Chapter V: Tests used in diagnosis of aural disease. The present paper includes Chapters I-III; Chapters IV and V will follow in a subsequent article.[1]

CHAPTER I.

MENTAL TESTS AND THEIR RELATION TO PSYCHOLOGY AND PATHOLOGY.

The term "test" implies the existence, or possibility, of an average quantitative expression for a physical or mental characteristic or capacity, to which as a standard or norm the measurements of given individuals may be referred. The standard or norm value is taken as the average or mean of the measurements of many individuals with regard to the characteristic concerned. This concept lies at the basis of anthropometry.

This science has confined itself thus far almost entirely to physical measurements of the human body. Anthropometrists have compiled tables which show the normal height, weight, strength, lung capacity, length of arm, and other purely physical characteristics, of the typical individual, in various classes arranged according to age, sex, race, occupation and other differentiae. The normal proportions between various measurements, as those of girth and height, have also been recorded. Such norms are ideal values secured by taking the average or mean value of the particular measurements in a large number of individuals of a definite class; they represent the development which the normal individual within the class is most likely to possess. When norms are once established, the measurements of given individuals can be referred to them, and the individuals classed as normal, or as sub-normal or super-normal in a certain degree, with respect to the particular characteristics. The results of physical anthropometry are valuable, first of all, as scientific facts: like the facts of astronomy, they have a value in and of themselves. They find a considerable practical application as well. Successive testing of the same individual measures the influence of exercise, employment, or habits

[1]The writer wishes to express his obligation to Professor I. Madison Bentley, of the Department of Psychology, Cornell University, for putting at his disposal the contents of an unpublished paper on tests of audition, which proved very valuable in giving a starting point for the writer's own investigations.

of life, on his physical organism. Anthropometrical examinations guard the entrance to certain occupations, as the army and police, and in some instances admission into public schools. Such measurements have been adapted by A. Bertillon to furnish an accurate system of identification of criminals. They have recently been introduced into public schools to detect abnormal bodily development and make physical training effective; and their results are throwing light on other pedagogical problems. In all such measurements, there is assumed an average typical development for members of each class, and individual variations from this norm are regarded as of significance. In these physical measurements, which comprise thus far the great bulk of anthropometrical investigations, there is coming to be general agreement as to the dimensions and proportions which shall be noted, their normal values, and, to some extent, the significance of deviations from these values.

Anthropometry has shown also a tendency to use tests involving mental factors and, indeed, to measure mental characteristics themselves. Francis Galton included certain mental measurements in the anthropometrical investigations which he suggested in 1882[1] and afterward carried out. In 1890 the matter was brought to the attention of psychologists by Cattell's article in *Mind*[2] on "Mental Tests and Measurements." He had already applied measurements to typical mental characteristics, and in this article advocated the adoption and wide use by psychologists of tests of vision, audition, reaction time, and other mental phenomena. Other investigators took up the matter, and a few years later, in 1895, the American Psychological Association appointed a committee to select a series of tests through which there could be established "the normal capacity of simple and typical sensory, motor and intellectual endowment in the average individual and in groups; the distribution of these capacities, their correlation, development, and relation to daily activities."[3] The tests were to be used in psychological laboratories upon large numbers of college students and other individuals, and in this way data secured "for the study of general, typical, characteristic endowment, much as the anthropometrist desires first to establish standards of the principal physical measurements and proportions."[4] Such tests were instituted at Columbia, Wisconsin, and some other universities. A programme closely related to that of "mental tests" is the individual psychology proposed in France

[1] *Fortnightly Review*, xxxvii, 1882, 332.
[2] *Mind*, XV, 1890, 373.
[3] J. Jastrow (member of committee): *Psychological Review*, V, 1898, 172.
[4] *Ibid.*

by Binet and Henri and in Germany by Kraepelin and Oehrn. Its problem, as stated by Binet and Henri is (1) the study of the variable properties of psychical processes,—how and to what extent processes vary from individual to individual; and (2) the discovery of the interrelations of these variable properties in the individual mind. Without reviewing the literature of either mental tests or individual psychology at this point, we may say that each proposes to measure such mental functions as memory, association, reaction-time, imagination, audition, vision, attention, etc., in large numbers of individuals; to determine norms as physical anthropometry has done; and to discover and interpret individual variations from them. Each, moreover, expects to contribute to the science of psychology. It will, therefore, be desirable to determine at once how mental tests are related to psychology and whether they come within its scope as a science.

Now modern psychology may take three more or less clearly defined attitudes toward its subject matter, mental experiences. (1) It may regard mental stuff statically, as structure, disregarding its reference in the environment and its significance to the individual. It then finds its immediate problem in the analysis of consciousness into structural elements, the sensations and affections, and in the statement of the laws governing their interconnection in the structural complexes found in consciousness. (2) It may regard the processes dynamically, as functions of the psychophysical organism, having meaning to the organism in its relations to the outside world. The problem, as before, is, first, analysis, but now into elementary functions; and secondly, a statement of the laws governing their interaction. (3) It may regard mind as in process of development and trace its progress genetically in the race or in the individual. Since this genetic attitude may be either structural or functional, the primary psychological standpoints reduce to two. To which of these are mental tests related? In general, not to structural psychology, we may say, since one tests the individual in some mental characteristic regarded in its significance to him and without regard to its structural aspects, the sensations and affections which make it up. The answer is not so easy regarding the relation of mental tests and functional psychology. They work upon common material, namely, mental functions. They may be concerned with the same function. Yet, from the standpoint of scientific methodology, with which the decision must finally rest, mental tests and functional psychology lie outside each other, and mental tests, as tests, are not a part of the science of pure psychology. Psychology approaches its problem with trained observers, delicate apparatus, careful procedure designed to check errors, rigid experimental conditions,

and with the single purpose of seeing and describing the phenomenon as it is. A mental test of the same function involves the examination of untrained subjects, under limitations of time which make refined measurement and precise procedure impossible, and with the subjective conditions of tranquility, attention, and knowledge of the problem varying widely from observer to observer. Norms are based upon such measurements, and the individual's variation from them is interpreted for some practical end, perhaps medical diagnosis, or a characterization of the individual as of normal capacity in a certain direction. Psychology, on the other hand, does not recognize individuals as such. Just as it is not a fact in the science of theoretical physics that a certain engine produces a certain amount of power per fuel unit, so it is not a problem for psychology to evaluate John Smith's memory or attention. The former problem falls to the province of engineering, an application of pure physics; the latter, a typical mental test, is just as certainly an application of psychology, and is not to be regarded as within its limits as a theoretical science. Further, psychology of function, as a science, has no room for the practical, extra-scientific ends involved in mental tests; it measures mental processes simply to make possible a complete statement of the functional elements of mind and their interaction.

This distinction, which puts mental tests outside psychology, does not exclude the possibility of a scientific individual psychology, which, as Henri and Binet propose, shall describe the variations of mental processes from mind to mind. The objection is simply against the attempt to found such a psychology on the rapid, necessarily inaccurate, and wholesale testing of miscellaneous individuals. The painstaking determinations of trained psychologists, working with refined methods and selected observers, may alone be expected to build up a trustworthy body of facts for a psychology of the individual. The progress of child psychology is illuminating and admonitory in this connection. The established facts regarding the child's mind have been secured by a half-dozen trained investigators through long-continued observations of children; while the mass of facts secured by the questionary and the untrained observations of parents and teachers are largely either unreliable or outside of psychological science. So, doubtless, the development of functional psychology, whether individual or general, will depend on the investigations of experienced psychologists, working with practised observers, and not on the statistical treatment of measurements made on large numbers of individuals taken at random. Mental tests, as tests, therefore, are not to be regarded as part of psychology, neither should direct contributions to psychology be expected from them. Psychology, on the other

hand, can do a great deal for mental tests. In the first place, it must guide in selecting the tests to be employed; and, secondly, it must furnish appliances and methods of procedure, to be adapted as the grosser work of the tests may require.

In concluding this discussion, then, we may say that mental tests, as tests, are more akin to physical anthropometry than to psychology. They are to be sharply distinguished from the measurement of mental functions in psychology, both because of the differences in refinement of method, and particularly because they are applied to masses of individuals to determine norms, individual variations from which are interpreted with regard to some practical end. Mental tests may be considered as an application of psychology, and in so far they are related to it. In the methodology of science, it seems proper to term them, as has been suggested, mental anthropometry.

There remains the further question of the relation of mental tests to pathology, in particular to medical diagnosis. In discussing the applications of physical anthropometry, we mentioned that it has been found useful, as in gymnasiums, in detecting poor physical development, in indicating the exercise or other treatment needed, and in measuring the response of the physical organism to such treatment. Certain tests involving mental factors are used in a very similar way to determine the presence of diseased or abnormal conditions, as the tests of vision, audition, and the rough tests of intelligence to determine insanity. The oculist uses a series of tests whose results indicate primarily the normal or abnormal condition of the visual organs, and, further, if the eye be abnormal or diseased, reveal the nature of the disease or abnormality. Similiarly, the aurist employs tests which indicate whether hearing is sound and normal, and certain other tests which, in case of diseased or abnormal conditions of the ear, reveal the origin, nature, and extent of the disturbance. In such tests, at least so far as diagnosis of disease is involved, we are in the field of pathology. Because of their significance in identifying diseased conditions, they may be called diagnostic tests. While such determinations are primarily matters of pathological practice, yet they involve mental factors, and so become of interest not only for their own sake, but for their relation to psychology. In any case, they should be included, to make our systematic presentation complete. In our treatment of auditory tests, we shall accordingly discuss, first, tests measuring the normal condition of the auditory organ and variations from the normal; and, secondly, certain tests useful to otology, the special branch of pathological science treating of aural disease.

CHAPTER II.

LITERATURE.

This sketch of the literature of mental and auditory tests will not attempt an exhaustive review of all that has been written on the subject. The general bearings of both mental tests and individual psychology, and their literature down to 1898, have been reviewed by Miss Sharp in her article on Individual Psychology;[1] and the literature of auditory tests up to ten years ago, has been summarized by Chrisman.[2] Further, as we come presently to consider various tests of audition, we shall be in constant reference to the literature. For these reasons, a detailed examination of all the literature would be superfluous. At the same time, a brief review of the principal statements of mental tests will be valuable in giving perspective and in relating the present work to that of previous writers, particularly American.

Mental tests, as already stated, go back to Francis Galton. His article on "The Anthropometric Laboratory" in 1882,[3] urged the establishment of laboratories where measurements of purely physical characteristics and of certain mental characteristics as well, could be made. The tests which he suggested include, in addition to purely physical measurements, the following: strength by dynamometer, muscular agility, co ordination of eye and muscle, sight, hearing, touch, muscular sense, reaction-time, after-images, and memory. Galton's tests of hearing embraced "keenness of hearing, and the appreciation of different degrees of loudness and of different tones." It is to be noted that Galton's standpoint, in suggesting such tests, mental and physical, is that of the anthropometrist. He called attention to the obligation of mental tests to psychology, a debt no one disputes, in his remark that from the work of Fechner and Delboeuf and similar investigators suitable instruments could be selected for "an anthropometric laboratory." He said nothing of possible contributions from mental tests to psychology; this idea was developed, as we shall see presently, by later writers whose interests were in psychology, not in anthropometry. It is important to note that mental tests were first suggested by Galton as anthropometric measurements, quite on a par with physical measurements, without a thought that they would be anything more. This may be fairly inferred from the reasons which he gives for performing such

---

[1] S. E. Sharp: *American Journal of Psychology*, 1899, 329-348. See also her conclusions, pp. 388-391.
[2] Oscar Chrisman: *Pedagogical Seminary*, ii, 1892-3, 397.
[3] *Fortnightly Review*, xxxvii, 332; reprinted in *Popular Science Monthly*, xxi, 53.

tests.[1] It would be interesting to follow Galton's development of the idea of mental tests further; but it must suffice to call attention to his book of 1883, "Inquiries into Human Faculty,"[2] and to the establishment of a temporary anthropometric laboratory in 1884 in connection with the International Health Exhibition at South Kensington, London. At this laboratory, various measurements, some purely physical, some involving mental factors (*e. g.*, the highest audible tone), were made upon over 9,000 persons.[3] The anthropometric laboratory was maintained at South Kensington until about 1895, and then removed to Oxford.

With Galton, mental tests were simply a branch of anthropometry. Their attention at the hands of psychologists seems first to have been due to Cattell. In 1885, and subsequently, he published the first contributions to individual psychology,[4] and in 1890, his article in *Mind*[5] brought the subject of mental tests to the attention of psychologists. Cattell's article was at once an outline of tests already performed, and a suggested programme of tests for general use in the psychological laboratories then forming in American universities. Cattell's tests all involved mental factors, some, as dynamometer pressure, including as well prominent physical factors; others, as memory, being purely mental. It is important to note that his purpose in performing the tests was primarily psychological, to contribute to the science of psychology. He says: "psychology cannot attain the certainty or exactness of the physical sciences, unless it rests on a foundation of experiment and measurement. A step in this direction could be made by applying a series of mental tests and measurements to a large number of individuals. The results would be of considerable scientific value in discovering the constancy of mental processes, their interdependence, and their variation under definite circumstances." While recognizing the practical possibilities of tests, Cattell here apparently puts considerable faith as well in their "scientific value" for psychology. This was in 1890. We may fol-

[1] Galton's reasons are: (1) biographical interest; (2) medical interest to the person tested; (3) information for descendants as to hereditary dangers and vital probabilities; (4) material for investigations into life histories.

[2] Now, unfortunately, out of print.

[3] *Anthropological Institute Journal*, xiv, 1884-5, 205, 275; *ibid.*, xvi, 2. For other references to Galton's work, *cf. Science*, v, 294, and viii, 374. *Nature*, xxxi, 223. *Cf.* also *Lippincott's Mag.*, xlv, 1890, 236, *Why We Measure Mankind*, by Galton.

[4] *Cf.* foot-note, *Psych. Rev.* iii, 1896, 618. Cattell here says that the introduction of individual psychology was delayed because Wundt "was not favorable to it."

[5] J. McKeen Cattell: *Mind*, xv, 1890, 373, *Mental Tests and Measurements*.

low this trend toward a psychological evaluation of mental tests further.

The idea of contributing to psychology by wide-spread testing and measurement seemed to secure general favor. Jastrow, in 1891, published the results of some tests on the community and association of ideas in men and women.[1] In 1892, there were published the results of a series of anthropometrical and psychological tests carried out under Jastrow's direction on students at the University of Wisconsin.[2] The next year, Jastrow conducted a psychological laboratory at the Columbian Exposition in Chicago, in part similar to Galton's anthropometric laboratory, but giving more attention to strictly psychological tests.[3] In the same year (1893), there were two statements of mental tests, by Scripture[4] and Cattell[5] respectively, especially in their relation to school children. The practical value of tests was urged by both, and both seemed impressed with "the scientific value of such tests on large numbers of persons," as Scripture broadly puts it. Cattell, indeed, states explicitly the position with which the writer has taken issue. In urging teachers to perform tests upon school children, he says, "those who wish to contribute to the advancement of psychology will find this a convenient opening." This is a rather radical statement of the relation of tests to psychology, but it seems to represent the prevalent feeling of the time that in mental tests and statistical methods psychology had a new organon. At this juncture, when the proposed psychological laboratory at the Columbian Exposition was under consideration, Titchener published an article on the relations of psychology and mental tests in which there are stated, explicitly

---

[1] Joseph Jastrow: *A Study in Mental Statistics*, *New Review*, v, 1891, 559; *A Statistical Study of Memory and Association*, *Educational Review*, ii, 1895, 442. Another study by Jastrow was published in 1894: *Community and Association of Ideas: A Statistical Study*, *Psych. Rev.*, i, 1894, 152. This last test was repeated at Wellesley College with different results, under the direction of M. W. Calkins: *Psych. Rev.*, ii, 1895, 363. A criticism of the latter by Jastrow followed: *ibid.*, iii, 1896, 68; to which Miss Calkins replied, *ibid.*, 426. Jastrow made another reply: *ibid.*, 430. The Wisconsin and Wellesley tests are criticised by Amy Tanner: *ibid.*, 548.

[2] *Am. Jour. Psych.*, iv, 1892, 420. The tests were performed in the fall of 1890.

[3] "Experimental Psychology at the World's Fair," an outline of plans given in an address by Jastrow before the American Psychological Association, Philadelphia, December 27, 1892. *Cf. Official Catalogue of the World's Columbian Exposition*, pt. 12, 50. For an analysis of the tests, *cf. L'Année psychologique*, i, 522. No results, as far as the writer has been able to learn, have been published.

[4] E. W. Scripture: *Tests of School Children*, *Educ. Rev.*, v, 1893, 52.

[5] J. McK. Cattell: *Tests of Senses and Faculties*, *Educ. Rev.*, v, 1893, 257.

or implicitly, many of the distinctions urged in our preceding chapter.[1] He raises the question pointedly: "What constitutes the difference between a psychological and an anthropometrical experiment?" and finds very valid differentiation. The psychological experiment assumes, on the part of the observer, "practice in introspection, in attentional concentration, and in control of the particular apparatus employed. The anthropometric measurement requires at most only enough practice to carry out instructions. The value of the former is as much qualitative (for analysis and description) as quantitative; the value of the latter is solely quantitative." Speaking further of the line between experimental psychology and anthropometry, he says, "It is as unfair to rob anthropometry of her experiments and dub them psychological, as it is to psychology to conceal the difficulty of her own experimentation by substituting the simpler anthropometrical for it." Though this article was written with the simple aim of making suggestions as to the psychological exhibit at Chicago, it had in it a wider significance, in implicitly drawing the line of demarcation between the exact introspective experimentation with trained observers which lies within psychology, and approximating measurements of mental capacity, made upon miscellaneous individuals, which lie outside psychology. If the validity of the distinction suggested in Titchener's article had been recognized, mental tests would not have been welcomed, as they were, as a new and promising psychological method. The distinction was not recognized, however, and mental tests for a time had their welcome in psychology. We may follow their fortunes further.

Gilbert, during 1893-4, made tests of the physical and mental development of New Haven (Conn.) school children.[2] These tests, he says, were "to aid in the analysis of mental phenomena,"—a purely psychological aim, surely. In December, 1895, the American Psychological Association appointed a committee, composed of Cattell, Baldwin, Jastrow, Sanford and Witmer, "to consider the feasibility of co-operation among the various psychological laboratories in the collection of mental and physical statistics."[3] Cattell and Farrand, in 1896, published a report of physical and mental tests on students of Columbia University.[4] In this article, they state the purpose of

---

[1] E. B. Titchener: *Anthropometry and Experimental Psychology*, *Philos. Rev.*, ii, 1893, 187.

[2] J. A. Gilbert: *Studies from Yale Psych. Lab.*, (Nov. 1894) II, 40-100. His mental tests measure muscle-sense, color-perception, suggestion, motor ability, fatigue, reaction-time, discrimination-time and time memory.

[3] *Psych. Rev.*, iii, 1896, 122.

[4] *Ibid.*, 618.

such tests to be "the study of the development and correlation of mental and physical traits. . . . . The tests have two chief ends, the one genetic, the other quantitative. We wish to study growth as dependent on environment and heredity, and the correlation of traits from the point of view of exact science." The authors seem to have accepted something of the distinction urged by Titchener three years before, and to have in mind the limited psychological bearing of mental tests, for they refer to them as "anthropometric work." The reasons urged for the performance of tests are largely practical rather than scientific: they say that the tests are of interest and value to the individual; may make the psychological laboratory of value to the community in school tests, medical practice, etc.; and give advanced students practice in research. On the other hand, they find certain psychological ends for mental tests, since they are to study (1) the interrelation of the traits defined and measured, and (2) the development of the individual and the race. The first of these aims falls in with individual psychology, the second with genetic; and so far the authors seem to hold to the psychological possibilities of mental tests.

The committee of the association presented its preliminary report in December, 1896.[1] A second report, followed by discussion, was made at the meeting a year later.[2] In the former report, the purpose of mental tests is stated briefly; "to reveal individual differences and development." On the latter occasion, Jastrow gave a paper on "Popular Tests of Mental Capacity," which was supplemented by statements from Baldwin and Cattell. Jastrow was at pains to differentiate "the careful and ingenious analysis on the part of well trained and scientifically self-observant experimentalists," to which he says the main equipment of a psychological laboratory may wisely be devoted; and investigations "to establish the normal capacity of simple and typical sensory, motor, and intellectual endowments," in the average individual or in selected groups, and the distribution, development and correlation of such powers,—in short, tests or "mental anthropometry." Though in this statement, Jastrow distinctly separates tests and psychology, it is doubtful whether the distinction has been clearly recognized in psychological thought at large. Jastrow himself in his latest statement says:[3] "Call it mental anthropometry if you will, but do not disregard the valuable contributions to other divisions of psychology and to the general conceptions of this science which such investigation has the possibility, and in my opinion the probability, of contributing." He thus

[1] *Psych. Rev.*, iv, 1897, 132-138.
[2] *Ibid.*, v, 1898, 145, 146 and 172-179.
[3] *Ibid.*, viii, 1901, 14.

maintains the possibility of contributions to psychology from mental tests, as does Cattell in the last statement quoted from him. On the other hand, the fact that seven years have passed since the committee suggested its tests, and that psychologists have not made any considerable contributions in this field indicates that, whether consciously or not, the distinction between mental anthropometry and psychology has come to be accepted. Some tests have indeed been performed.[1] One of the investigators, Seashore, seems clear with regard to the distinction just referred to: "most of the development of a problem," he says, "can be carried on to the greatest advantage by the ordinary method with trained observers; it is mainly when we wish to determine the nature of the naïve experience or the uniformity of a certain tendency that we find it profitable to appeal to the statistical method."[2]

There are indications, indeed, that the practical purposes in mental tests are coming to be recognized as the real and only reason for their performance; and that the hope of making them contribute to psychology is being given up. The practical end has been recognized from the first by Galton, Cattell, Jastrow, and others, as a large reason for performing tests. It seems fair to say that the present attitude toward mental tests, in so far as there is such an attitude, emphasizes the practical and minimizes the psychological aspect. The fact that psychologists have gone into public schools with tests and urged practical benefits from their performance; the fact that, despite "possible and probable contributions" to psychology, one does not actually find that such contributions have been made;[3] the fact, finally, that the public schools themselves are instituting mental tests for practical purposes,[4] indicate that mental tests are finding their place as a form of anthropometry carried out on large bodies of individuals for practical ends, and not as

---

[1] J. A. Gilbert: *Researches on School Children and College Students*, *Univ. of Iowa Studies in Psych.*, i, 1897, 1; C. E. Seashore, *Some Psychological Statistics*, *ibid.*, ii, 1899, 1; E. A. Kirkpatrick, *Individual Tests of School Children*, *Psych. Rev.*, vii, 1900, 274.

[2] *Univ. of Iowa Studies in Psych.*, ii, 1899, 3.

[3] One of the latest contributions to mental tests is C. Wissler's *Correlation of Mental Tests and Physical Tests*, *Columbia University Dissertations*, *1901*. Wissler compiles the tests made for several years at Columbia by Cattell and others and concludes that (1) the laboratory mental tests show little inter-correlation; (2) the physical tests show a general tendency to correlate among themselves but only to a slight degree with the mental tests.

[4] The most striking example of this is the Department of Child Study and Pedagogic Investigation, of the Chicago Public Schools. *Cf.* its reports, 1898-99 ff. *Cf.* also A. MacDonald: *Report of U. S. Commissioner of Education*, 1897-8, 989 ff. and 1281 ff. Tests on a less extensive scale have been made in other schools.

a branch or method of pure psychology. If the discussion in this paper helps to make the distinction between psychology and mental anthropometry more explicit, and calls attention to the emphatically practical purposes of the latter, one of its aims will have been accomplished.

The present paper is an attempt to describe, criticise, and arrange tests of audition, which will admit of application by unskilled investigators. It recognizes the practical purposes of tests and formulates testing methods for extra-psychological ends only. It is not a contribution to psychological science, but to an application of psychology, mental anthropometry. This may itself in time become a scientific discipline; and this paper is offered as a modest contribution toward that end. As already stated, the auditory tests which will be considered are of two classes, anthropometrical and diagnostic. The former fall into two divisions: those of general auditory acuity, and those of musical capacity. These will be treated in Chapter III and Chapter IV respectively. Diagnostic tests occupy the concluding chapter, Chapter V.

CHAPTER III.

Tests of Acuity of Hearing.

This chapter falls into two parts: (a) tests which employ speech in examining acuity of hearing; and (b) tests of acuity with mechanically produced tones and noises.

A. Speech Tests of Acuity of Hearing.

The most important function of the human ear is the hearing of conversational speech. No examination of the auditory organ is entirely adequate unless it determines the practical efficiency of this capacity. Impaired acuity of hearing ordinarily first manifests itself by inability to hear speech distinctly and easily. Further, in some aural diseases, the ear no longer hears certain vocal elements, *e. g.*, the low, deep sounds of speech, or words containing them. Tests with spoken words may be employed to disclose either of these disturbances. Speech tests for diagnostic purposes, *i. e.*, to determine those vocal elements which have become imperceptible through disease and to interpret their loss as indicative of certain aural diseases, will be considered in a later section, under diagnostic tests. Here we are concerned only with tests employing speech to measure the degree of general auditory acuity. In such tests, words are commonly spoken at various distances from an individual and the maximal range is determined at which he hears the words correctly.

The reasons for employing speech tests may be briefly stated:

(1) They measure directly and unequivocally the most important function of the ear,—the hearing of conversational speech.

(2) Other tests do not measure this functional capacity. The results of tests with the watch, acoumeter, audiometer, tuning forks, and other mechanical sources of sound may not be considered an unequivocal measure of the individual's ability to hear speech.[1] Thus, one may hear the watch at a considerable range, and yet be relatively deaf for speech, or conversely. The ratio between the range for speech and that for a single tone, or noise, is not necessarily constant, even in the same individual. The reason for this is evident. Hearing a watch or acoumeter click, or a single tone, involves the perception of a limited number of auditory qualities, and, assuming the Helmholtz theory of audition to be correct, the normal functioning of a restricted and constant part of the basilar membrane. Perception of speech, on the other hand, requires the hearing of a large number of tonal qualities and noises of high, low and medium pitch, and, accordingly, unimpaired physiological functioning over a wide stretch of the basilar membrane. Further, defects in other parts of the auditory organ, as in the drum, or the chain of ossicles, might accommodate the transference of sound of one pitch, say that of the watch, and prevent the passage of certain sounds in the wider range of speech. For these reasons, speech tests alone are entirely reliable in determining the functioning condition of the ear for practical usefulness in life. Accordingly, while conditions will often dictate the use of the mechanical tests of hearing, explained in the next section, speech tests should, where possible, be given the preference.

The problem of arranging speech tests is as follows. The syllables, words, or sentences to be used in the tests must be chosen; the conditions under which the tests are to be applied must be stated; a large number of individuals must be tested and the normal range for speech perception determined, so that the individual's range, and hence his acuity of hearing, can be interpreted in terms of the norm. This problem is more complicated than it seems at first to be.

The selection of speech tests is difficult, first of all, because of the great variety and complexity of sounds involved in human speech. The elements of spoken speech vary in pitch, intensity, complexity, and clang-tint or 'quality.' Some elements, the vowels, are approximately pure clangs with faint

[1] *Diseases of the Ear*, D. B. St. J. Ross, New York, 1885, 49-50. *Diagnosis and Treatment of Ear Diseases*, Buch, New York, 1880, 17. *Ohrenheilkunde*, A. Politzer, Stuttgart, 1893, 115, 119. *Schuluntersuchungen ü. d. kindliche Gehörorgan*, F. Bezold, Wiesbaden, 1885, 9.

traces of noise-elements; others, the consonants, are noises with more or less slight admixture of tonal elements.[1] As spoken in words and sentences, speech presents further complications due to accent, emphasis and inflection. The classical investigation of speech in its relation to audition is that of Oscar Wolf.[2] Its most important feature is a statement (*a*) of the pitches of the elements of speech and (*b*) of their intensities. (*a*) *The pitch of speech-elements.* Wolf accepted the pitch determinations for vowels made by Helmholtz, and made similar determinations for all consonants having vowel elements. The results are expressed in musical symbols or vibration rates, *e. g.*, the vowel "a" has a pitch of b^2 or 896 vibrations; the consonant "b," a pitch of e^1 or 320 vibrations The various vocal elements extend in all over eight octaves, from the lowest sound, lingual-R which contains a tone of 16 vibrations, to the highest, the S-sound, with a tone of c^5 or 4,032 vibrations. In Wolf's classification, the consonants h, l, m, n and w are assigned no pitch, as they are in themselves devoid of characteristic tone, and assume that of the vowel to which they are associated. (*b*) *The intensity of speech-elements.* Wolf measured this by the comparative distances over which the various elements of speech carry and are still audible.[3] The vowel "a" (as in father) has the greatest range, 252 m.; the aspirate "h," the shortest range, 8.2 m. The other sounds fall between these limits, the vowels having much longer ranges than the consonants. The vowels, indeed, may be distinguished at distances at which the consonants are all inaudible. The consonants, further, vary very widely in their relative ranges. These determinations of Wolf, which furnish a complete inventory of the pitches and intensities of the elements of speech, have made possible its accurate application in auditory tests. Later investigation will doubtless set aside parts of Wolf's work, particularly the pitches assigned to the various vocal elements. L. Hermann,[4] for example, has analyzed the vowels phono-

---

[1] W. Wundt: *Grundzüge d. phys. Psych.*, ii, 1893, 49.

[2] *Sprache u. Ohr*, O. Wolf, Braunschweig, 1871; and various articles in otological journals, particularly, *Arch. f. Augen- u. Ohrenheilkunde*," III, Abth. 2, 35; and IV, Abth. 1, 125; and *Zeits. f. Ohrenheilkunde*, XX.

[3] C. Blake made a mechanical analysis of the relative intensity of consonants (*Zeitsch. f. Ohrenheilk.*, XI, 1 Heft). His results do not agree very well with those of Wolf. The latter's results are certainly to be followed in making speech tests, since he measured intensity by the relative distance at which the speech elements are heard by the human ear.

[4] *Pflüger's Archiv*, xlviii, 371 and liii, 1. Summary in Wundt, *op. cit.*, II, 49, 51, where a table compares Helmholtz' and Hermann's results. See also Helmholtz, *Sensations of Tone*, 1895, 109, for a comparative table of the pitches assigned the vowels by various investigators.

photometrically, and reached results which vary quite considerably from those of Helmholtz, whom Wolf follows in the pitches of vowels. The vowel clangs are found to be richer in distinguishable over-tones, than with Wolf, and variations in the absolute pitch of tonal elements are discovered. Recent work by Scripture[1] calls attention to the fact that the pitches are nearly always changing, and have values that vary with the interconnection of syllables, and the turns of expression given the words.[2] On the other hand, Bezold reaches results confirmatory of the earlier work of Helmholtz and Wolf as to the pitches of vowels and consonants. Doubtless, there will be restatements of these values, perhaps in terms of the variable pitches to which Scripture's results call attention, before final agreement is reached; yet for the purposes of tests one is safe in following Wolf and the later otologists who have developed and applied his results. In our present enquiry, the selection of speech tests, the following facts, established by Wolf, are important:

(1) Vowels carry farther than consonants.[3] Words with the vowels of light clang-tint,—a, e, i,—are more easily understood than those with the vowels of dark clang-tint,—o and u.[4] (German sounds).

(2) The consonants h, l, m, n, and w may be disregarded in speech tests, since they have no tones of themselves, but depend upon the vowel preceding or following.[5]

(3) The consonant sounds to which special regard must be paid in making tests are grouped by Wolf as follows. The range of each element in loud speech is also given:

I group:	High and strong: Sch,	200 paces.
	S,	175 paces.
	Soft-G, or Ch-soft,	130 paces.
	High and weak: F,	67 paces.
II group:	Medium pitch, the explosives.	
	K and T,	63 paces.
	B,	41 paces.
III group:	Deep sounds.	
	Lingual-R,	41 paces.
	[U (whispered, in diagnosis)	50 paces.]

[1] E. W. Scripture: *Studies of Yale Psych. Lab.*, 1899 and 1902; and *Philosoph. Studien*, xix, 599.

[2] *Zeits. f. Ohrenheilk.*, xxx, 1897, 114.

[3] Stated also by Helmholtz, *op. cit.*, 68.

[4] Wolf: *Sprache u. Ohr*, 96.

[5] Wolf: *op. cit.*, 15. Wolf's statement may be overstrong. In words, these letters of course take on pitch values, so that Scripture assigns them pitches as other sounds. Doubtless, too, they have some tonal elements of themselves.

These are the three characteristic groups of consonants in Wolf's system. Any adequate speech test must examine the perception for sounds in all three classes. Since the vowels are of farther range than the consonants, testing is based on the hearing of consonant sounds. Regard need be paid to the vowels only to include those of dark as well as of light clang-tint. There are other considerations in addition to the necessary inclusion of consonants and vowels of the classes just mentioned, which determine the selection of the actual words or other speech material to be used in the tests.

This material might include (*a*) the sounds of the letters pronounced separately, (*b*) these sounds joined into nonsense syllables, (*c*) sounds joined into words, or finally (*d*) words joined into sentences. Wolf found the simple unconnected sounds of the letters desirable in diagnostic tests: of these we shall speak later. In the testing of acuity, which we are considering here, sentences are objectionable, since the person tested may hear certain of the sounds or words, and then, aided by inflection and emphasis, only too easily guess at the whole expression. Words are open to the same objection, though in a very slight degree, since inflection, emphasis, and context are lacking. Nonsense syllables and the disconnected sounds of the letters avoid this difficulty, but they are open to the weightier objection that they do not directly test hearing for conversational speech,—our aim in this determination. All things considered, single disparate words recommend themselves as the material for the tests.

Granted that words should form our testing material, there is the further problem of the particular words to be chosen. In such a choice, regard must be paid to two conditions: (1) the structure of the words, *i. e.*, the vocal sounds included in the words and the interconnections in which the elementary sounds stand; and (2) the meaning of the words chosen. Under the first condition, provision must be made, as we have seen, for consonants of Wolf's three classes, and as far as possible all other elements of speech, including vowels of dark and light clang-tint. In addition, the following minor points[1] should be observed as far as possible: i. Words beginning with two consonants present difficulties in defective hearing and may well be included in the series of test words. ii. Perception for a consonant sound varies slightly, in some cases considerably, according as it appears as the initial, final, or emphatic syllable in a word. This point is of importance in diagnostic tests rather than in this general test; nevertheless, words with consonants in a variety of positions are desirable. iii. A regular

[1] Wolf: *Sprache u. Ohr.*, 95-96.

alternation of vowels and consonants in a word facilitates its perception.

The second condition limiting choice of test words, that of their meaning, is based on the fact that the ease of perception of a word varies directly with its familiarity. This is a very important factor. In ordinary conversation, we apperceive much more than we actually hear.[1] As already stated, this makes sentences undesirable for testing. With single words, even, it is unavoidable that to some indeterminate extent the test word will be apperceived when only part of its constituent sounds are heard. The determining factor in apperception of a disparate word from partial hearing is the degree of familiarity of the hearer with the word. An illustration will show where this fact leads us. The word "electricity," for example, other things equal, will be perceived accurately at a greater distance by a student of physics than the word "calico." The former word fits into his most common thoughts, and the least auditory suggestion of its sound is sufficient to evoke the verbal idea. The latter word, on the other hand, is an unusual one in his circle of thought, and a distinct perception of its auditory symbol is necessary to call the verbal idea to mind. To assume to compare the range of hearing for one word with that for another, as is necessary in testing a single individual, it is evident that we must have a series of test words with which the person tested is uniformly familiar, words whose sounds are equal in apperceptive value, *i. e.*, in calling up the verbal ideas corresponding to them. Let us follow our illustration farther. While a student of physics would understand the word "electricity" at a greater distance than the word "calico," a dry goods clerk would reverse the relative facility of apperception, and hear the word "calico" relatively farther than the word "electricity." As it is necessary to secure comparable results from various individuals, in order to determine the normal range for hearing and evaluate individual variations from it, test words must be uniformly familiar not only to the single individual, but, as nearly as possible, uniformly familiar to all individuals tested. This second factor, that of uniform apperceptive value, might be satisfied in either of two ways. (1) In a negative way, by taking vocal sounds entirely unfamiliar to the person tested; *e. g.*, the individual speech sounds given disparately, or nonsense syllables, or perhaps rare English or foreign words. The disadvantages of this are obvious: the tests would rapidly become unpleasant; unmeaning vocal combinations, whether in nonsense-syllables or unheard-of words,

[1] W. C. Bagley: *The Apperception of the Spoken Sentence, American Journal of Psychology*, xii, 80.

are intrinsically difficult to understand, for in ordinary life one pronounces a new word two or three times before feeling sure it is understood correctly; finally, such tests are too far removed from practical hearing to measure the latter adequately. (II) In a positive way, uniform apperceptive value may be sought by taking words in common use, known to every one, and, as far as may be, equally well known to every one. Number-words, the names of the numerals one to ninety-nine or higher, have been suggested as meeting this requirement.

Number-words present three distinct advantages which recommend them for testing purposes: (I) As a group of words, number-words are doubtless the most uniformly known, with any individual, of any series that could be devised. 52 is as familiar as 26; 13 as 8, etc. (II) Of all words, the number-words are doubtless the most uniformly familiar from person to person, despite differences of age, occupation, etc. (III) They are understood by children easily and with practical uniformity. They are the first body of words systematically taught, and are of daily use in school. Hence number-words are especially suitable for testing the hearing of school children, even in the lowest grades. Allowances must, of course, be made in actual tests for younger children who can count to ten or twenty only.

In view of these advantages, which ensure comparable results in the individuals, and between individuals as well, number-words commend themselves strongly as the material for tests. This statement, however, looks only to the second condition of choice, the apperceptive value of words. Do number-words satisfy as well the first criterion; do they include the various elementary sounds, both vowels and consonants, in sufficient number and variety of arrangement, to give adequate testing material? The series, nine to ninety-nine, is obviously limited. There are within it twenty-seven primary words which, either standing alone as "five" and "thirteen," or forming double words, as "twenty-seven" and "fifty-six," give the ninety-nine different number words in the series. It will be to the point to examine the primary number-words with regard to their consonantal and vowel sounds. Webster[1] gives the following pronunciation, to which in some cases are added German equivalents[2] for convenience of reference to Wolf's standards:

1.	wŭn		6.	sĭks	
2.	tōō	ōō = approx. Ger. ū	7.	sĕv'n	
3.	thrē	ē = Ger. i or ie	8.	āt	ā = Ger. ē
4.	fōr		9.	nīn	
5.	fīv	v = Ger. w; ī = Ger. ei, ai	10.	tĕn	

[1] *International Dictionary*, 1903.
[2] C. H. Grandgent: *German and English Sounds*, Boston, 1892.

11.	ĕlĕv'n	20.	twĕntў ў = Ger. ĭ, also Eng. ĭ.
12.	twĕlv		
13.	thĕrtēn	30.	thĕrtў
14.	fōrtēn	40.	fôrtў
15.	fĭftēn	50.	fĭftў
16.	sĭkstēn	60.	sĭkstў
17.	sĕv'ntēn	70.	sĕv'ntў
18.	ātēn	80.	ātў
19.	nīntēn	90.	nīntў

An examination of these words shows the presence of the following speech elements, the accompanying numerals indicating the number of times each element appears:

Vowels

a	3 ā
e	8 ē, 7 ĕ, 1 ė, 2 ẽ
i	4 ī, 5 ĭ, 8 ў
o	2 ō, 1 ô
u	1 ŭ
oo	1 ōō

Consonants

8 f, 3 k, 2 l, 20 n, 6 r, 9 s, 20 t, 6 v, 3 w, 3 th (as in *thin*).

Thus there are included in the number series ten different consonantal speech elements, each present from two or three times to twenty times. Webster enumerates twenty-five consonant elements as belonging to the English speech. Those not included in the number series are: ch, b, d, g, h, j, l, m, ng, p, sh, th (as in *thy*), y, z, zh. The fact that the number series includes less than half the consonantal elements of speech seems at first to condemn it, as inadequate to form the basis of speech tests. The answer again is not so easy; the adequacy cannot be decided off-hand by a mere enumeration of the sounds present. If these sounds include types of all consonant elements, they may very well test adequately the hearing for all. Comparing the consonants of the number series with the classification of consonant elements given in Webster,[1] one notes that all classes of consonants find representation by one or more sounds in the number series except the momentary surds (b, d, j, g). The final decision, however, whether the number series has sufficient representatives of all types of consonants, must be based, not on a classification like that of Webster's, made with regard to the pronunciation of speech, but on a classification made with regard to the hearing of speech. The consonants of the number words must be referred to Wolf's

[1] *Op. cit.*, lxvi.

three-fold classification, and the adequacy of the number series judged by it. The following Table shows under which of Wolf's classes each number-word falls; if the word contains consonant sounds of more than one class, it is included under each such class:

LOW.	MEDIUM.	HIGH.
2	2	
3		
4		4
		5
	6	6
		7
	8	
	10	
	12	
13	13	13
14	14	14
	15	15
	16	16
	17	17
	18	
	19	
	20	
30	30	
40	40	40
	50	50
	60	60
	70	70
	80	
	90	

Three number-words, one, nine and eleven, do not contain consonants falling within Wolf's classification. This does not, of course, exclude them from use in the tests. Considering the words falling within the three classes, the primary number-words are found to be distributed among the three classes as follows:

	LOW.	MEDIUM.	HIGH.
No. of words exclusively in each class	1	6	2
No. of words in each class and in another class as well	3	8	8
No. of words in all three classes	3	3	3
No. of different words containing sounds of each class	7	20	13

Our examination of the twenty-seven primary words shows that they are well distributed in the three classes of consonants. With these primary words, are to be included, in selecting test

words, the double number-words made from the primaries, *e. g.*, thirty-one, fifty-six. The primary words and the double words give in all 96 words, exclusive of one, nine, eleven, which are at our disposal. This certainly will furnish adequate material for series of testing words, with few repetitions save as the primary number-words reappear, differently compounded, in the various double-words.

At this point, an objection that has been made against the use of number-words in tests must be considered. Politzer[1] urges that, as the tests involve the use of a few primary words, the numbers will be judged with increasing ease as the test progresses, and the subject will come to guess the words, by hearing the vowels only. This objection Politzer considers insuperable. It is answered, however, by experimental results. Bezold used number-words in a test of 1,981 school children and in other extensive tests, and employs them constantly in otological practice. On the basis of the results of his school test, he says that there is no evidence of increased ease in the perception of the words as the tests progress, and whatever error there is from this source is practically uniform, since all the subjects know that they are being tested with number-words.[2] The experience of the author indicates that practice is a considerable factor, at first, but one that quickly reaches its maximum. Politzer is doubtless right in his objection, but he overestimates its importance. The error is known in direction, fairly constant in different individuals, and from its quick rise and small magnitude practicably negligible. It is certainly preferable to the variable errors of unknown magnitude involved in the apperception of the miscellaneous words which we must use in case we discard number-words. It may be added that number-words are in common and successful use by European otologists.[3] The objection of Politzer may, therefore, be overruled.

We return to the problem of selecting test words. The next step is to arrange lists of number-words, each list to contain words representing all three groups of consonants, and as far as may be with vowels of both dark and light clang-tint, and with consonants in the various positions, initial, medium, and final. The following lists seem to meet these requirements. The lists, further, may be expected to give comparable results, since they are equivalent as regards the elementary number-words included in each, and as regards the relative prominence of the three classes of consonants in each.[4]

---

[1] Politzer: *op. cit.*, 117.
[2] Bezold: *Das kindliche Gehörorgan*, 5.
[3] Bezold: *Functionelle Prüfung*, 206.
[4] Each of the ten lists contains uniformly the following elementary number-syllables: 1, "one;" 1, "two;" 1, "three;" 2, "four's;"

I	II	III	IV	V	VI	VII	VIII	IX	X
6	84	19	90	25	14	8	52	73	24
29	69	53	7	13	31	93	35	41	95
42	17	34	39	46	[illegible]	27	64	16	62
87	92	28	62	7	65	60	81	95	49
53	33	97	84	54	98	15	6	57	[illegible]
94	26	45	21	70	76	74	19	38	71
70	50	72	56	91	40	36	78	20	16
35	75	60	75	83	23	49	40	89	3
18	48	3	43	68	52	82	23	64	58
61	[illegible]	86	18	92	87	51	97	[illegible]	37

Speech tests are ordinarily given in whisper tones. In cases of hard-hearing, and sometimes in ordinary testing, conversational tones or even louder tones are employed. The merits of these two degrees of voice intensity are as follows.

Conversational speech (1) measures unequivocally the auditory functioning of practical life. Infrequent cases occur in otological practice in which whisper speech is heard farther than conversation (Burkhardt-Merian); and the whisper range is not a definite function of the range for conversation (Politzer). (2) Conversational speech must be used in determining cases of hard-hearing.

Whisper-speech (1) has approximately one-third the range of conversation and so permits testing in more restricted quarters. (2) In whisper-speech the vowels are reduced in intensity, while the consonants are little changed, so that the intensity of the vocal elements is more uniform than in conversation. This reduces the likelihood that the words will be guessed when only the vowel sounds are heard. On this score, whisper-speech has a distinct advantage, particularly when a limited number of test-words, as the number-series, is used. (3) Whisper-speech practically tests hearing for conversation. For these reasons, whisper tests are desirable and generally adequate. Limits of space, indeed, will usually preclude the use of conversational speech tests.

2, "five's;" 2, "six's;" 2, "seven's;" 2, "eight's;" 2, "nine's;" 1, "thir—;" 1, "—teen;" 1, "twent—;" 8, "—ty's." The relative prominence of the three classes of consonants in the ten lists, expressed as ratios of low consonants to medium to high (*i. e.*, l: m: h), is as follows:

I, 4:11:8; II, 5:12:8; III, 5:11:8; IV, 5:11:8; V, 5:12:9; VI, 5:12:8; VII, 5:12:8; VIII, 5:12:8; IX, 6:10:8; X, 5:11:9.

The writer compared these frequencies of the number series with that obtaining in the miscellaneous words of conversational speech and literary English. These latter showed the three classes of consonants present in the ratio 6:12:8, which is practically identical with the ratios given by the lists of number-words above.

Before considering actual methods of testing, the following important preliminary points of procedure may be stated.

1. Words are more easily perceived when the hearer is accustomed to the speaker's voice. This desirable familiarity will be secured by the preliminary explanations and statements made regarding the tests, which should be supplemented by a trial series of whispered test-words given according to the method of the actual tests. This serves the further purpose of making the subject feel at ease during the testing. This last is a very important point with children, and scarcely less so with many older people.

2. Two seconds or thereabouts before each test word, a warning signal should be given to insure maximal attention when the word is pronounced. Some uniform mechanical noise, as the sound of a pencil struck on wood, makes a satisfactory signal. The customary word "ready," pronounced in loud tones, may be used; but this necessitates an adjustment of the vocal organs for conversational speech just before each whispered test word, and is likely to interfere with uniform intensity in the latter. The signal should be repeated to indicate that the word has been spoken.

3. In testing the hearing for one ear, this ear is turned toward the examiner and the other ear closed. This can be most conveniently accomplished by pressing the tragus with the finger against the mouth of the meatus. Or, stoppers may be employed: Wolf used a rubber stopper; Politzer, the moistened finger in the meatus, or an olive-shaped obturator; and Titchener recommends the cap-shaped rubber eraser (found on many lead pencils), filled with laboratory wax before using. Small corks softened with vaseline are also quite satisfactory. When loud words are spoken directly before a diseased ear in hard-hearing tests, one must be sure, when words are heard, that the ear on the other side is not functioning despite its closure. Dennert suggested the check test of stopping both ears and repeating the words before the diseased ear. If words are still heard, the results of the preceding tests are unreliable, as the perception in both tests was doubtless mediated by the other ear; if words are not heard with both ears closed, the former test of the diseased ear was reliable.

4. The subject must not see the lips of the examiner in the tests, as slightly deaf persons often unconsciously "read the lips." In tests of one ear, the subject sits sidewise to the examiner and his position in part guards against this error. It is safer to have the eyes closed or shielded; the mouth should be closed through the tests, as the intensity of sound varies according as the mouth is open or closed. Such precautions

should be observed constantly. Any intermission interferes with regular attention.

5. With children, special care is necessary. As suggested above, conversation about the test and friendly treatment will assist in putting them at ease. If inattention and restlessness intervene, the tests should be stopped and resumed later.

6. As far as possible, variations in the voice of the examiner must be avoided. An approximately even intensity may be secured by always pronouncing test words with the residue of air in the lungs after the normal expiration (Bezold). If the test words are given successively, there may be interpolated after each word a definite number of breathings, three or four, the following word being pronounced after the last expiration in the group of breathings. Regard must also be paid to securing uniform tempo and distinct articulation. It is impossible to rule out differences in clang-tint between different voices. The variations in the individual voice may be largely obviated by the precautions suggested, and with practice it attains a closer approximation to uniformity.

7. It is generally desirable to examine each ear separately and then to test binaural hearing. The binaural range (*a*) is often unrelated to those of the ears functioning separately; and (*b*) it is precisely this range which is of importance in daily life. In the binaural test, the subject faces the examiner and closes his eyes.

8. The testing room for whisper speech should have a range of 30 m., if possible. Tests may be made, however, with an extreme range of only 18-20 meters, and with the second method suggested below even shorter ranges are satisfactory. The normal whisper range given by various investigators, varies from 17-41 m.[1] These different values are doubtless ascribable to the use of whispers of different intensities, and to the varying acoustic conditions in the various tests. The acoustical error might be obviated by making tests in the open air; but such testing is not commonly practicable. By performing tests in rooms of average oblong shape, and noting dimensions and other matters of acoustical importance, as disturbing noises, investigators will add to the comparability of their results. Bezold found that bright sunlight streaming from a window across his testing room changed its acoustic properties. The room should be kept free from noise within and without. Uniformity

[1] The following ranges have been given as norms by various investigators: Hartmann and Siebenmann, 25-26 m. in a quiet room and 20 m. in a room disturbed by the noise of the day; O. Wolf, 20 m.; Chimani, with soldiers, 21 m. (Politzer, *op. cit.*, 116.) F. Bezold, in his tests of school children, 17-20 m; Matte and Schultes, testing soldiers with a medium strong whisper, 35-40 m.; *Zeits f. Phys. u. Psych.*, xvi, 308.

should be observed as to position of large pieces of furniture, opened and closed windows and doors, and other conditions affecting sound reflection. Tests for conversational speech require a range three times that for whisper-speech (Bezold), and so a minimum space of perhaps 50 m. A range-line should be chalked on the floor in the direction of the greater dimension of the room, passing through the center and scaled to meter and half-meter divisions. It may be supplemented, if necessary, by a meter stick for short ranges in hard-hearing. The examiner, in working up and down the range, should always face the subject squarely as he pronounces test words. The subject will have a constant position at the end of the range-line, where he should be seated comfortably. If the testing is by groups, the individuals may be seated along an arc of 15 m. radius cutting the range at right angles.

Actual Performance of Tests. If a group of subjects are to be examined, rough preliminary tests may be made by pronouncing number-words at various ranges, on the results of which the group may be divided into two or more sub-groups, each containing persons of about the same grade of acuity of hearing. This will facilitate the actual testing. The precautions already suggested are to be observed: familiarity with the speaker's voice and with whisper-speech, closure of the ear not under test, closing of subject's eyes and mouth, attention secured by the warning signal just before the test-word, uniformity in the examiner's voice, and constant acoustical conditions in the testing room. With the individual or group seated at the end of the range-line, the examiner pronounces successively in whisper-speech a series of ten number-words, at each of the ranges selected, following this procedure: The warning signal, or "rap," is given, followed at the conclusion of the next breath by the first test word, which is pronounced with the residual air in the lungs. It is followed by a second warning "rap," signifying to the subject that the word has been pronounced and that he may now open his eyes and write down the numerical symbol of the word heard, *e. g.*, 22 or 9. If he has heard nothing, he indicates this fact by a dash (——). Meantime, the examiner interpolates three complete breaths and then gives the warning signal preparatory to the second test-word. At the signal, the subject closes his eyes and sits at attention until the examiner at the end of the next breath gives the second test-word, indicating its conclusion by another signal. Thus there follow successively: three complete breathings, the preparatory signal, the test-word at the conclusion of the next breath, the concluding signal, and so on through the series of ten words. This is the general procedure in the tests. A further statement must be made of two methods, either of

which may be followed in the tests: (1) the common method of measuring auditory acuity by the extreme range of accurate hearing; (2) the author's method of measuring acuity in terms of degree of accuracy of hearing at some constant range or ranges.

Method of Extreme Ranges. In this method the examiner makes rough preliminary tests with a few whispered number-words to determine the subject's approximate extreme range. An accurate determination of the audible range is then made by beginning at a point on the range-line 3-4 meters beyond this approximate range and moving in by meter or half-meter intervals, giving a series of ten test-words at each point. The point at which the subject hears correctly some arbitrary part, say 80%, of the list of ten words, is regarded as the individual's extreme range. The average of the ranges of all the individuals tested under the same conditions is the normal range. The individual's auditory acuity is expressed as a fraction whose numerator is his own range and whose denominator is the average or normal range.

The propriety of this method depends on the assumption that the intensity of the sounds of speech decreases with approximate regularity as the distance from the speaker increases. The author's experimental use of speech tests has led him to doubt the truth of this assumption. As set forth in the appendix, his results indicate that in a closed room there is no regular scale of decreasing intensity as the range increases. There is a general decrease in intensity as the indoor range increases, but the reflection of sound-waves back and forth in the room makes almost meaningless such distinctions as that A hears 80% correctly at thirty feet, B at forty feet, and C at fifty feet. It may happen, as it did in the author's work, that it is paradoxically easier to hear words in the particular room at fifty feet than at forty feet. The existence of this source of error throws no little doubt, in the author's opinion, upon the work which has heretofore been done in speech tests. Further experimental testing is needed before final conclusions can be stated regarding the extent to which the above method is trustworthy. Meantime, the following second method of procedure is advanced with the design of avoiding the error due to reflection of sound-waves, which seems to be inherent in the above method.

Method of Degree of Accuracy. In this method, one, two, or more, constant ranges are selected according to the testing space at the disposal of the examiner. If a single range is used, it should be on the border line of difficult hearing; if three ranges are chosen, one may be at easy hearing distance, one at a moderately difficult distance, and one at a quite difficult distance.

All ten testing lists, *i. e.*, the whole hundred testing words, are then spoken at the single range; or if more than one range is used, the words are divided about equally between the two or three ranges. Each individual is examined with the 100 words, and his results are computed as to the percentage of accurate audition. The norm is taken as the average of all the individual percentages; and each individual's audition is then expressed as a fraction of this norm. If time is valuable, the test may be shortened to fifty words or even less. If space is restricted, the range may be shortened by the use of screens to cut off the sound-waves and so reduce the intensity of the sounds This may be easily accomplished by the examiner taking his position in an adjoining room with the connecting door open. It is necessary with this method, and especially so with artificially shortened ranges, that the examiner and the subject keep certain constant positions, even with regard to the direction of the head, throughout the entire series of tests.

The advantage of this second method lies in its freedom from the errors due to the reflection of sound-waves. With the examiner and subject in certain definite positions at a certain constant range, or ranges, the acoustical conditions remain uniform throughout the tests; and if A hears 80% accurately and B 60% accurately, it may be concluded with apparent certainty that A's hearing is more acute than B's. If the average accuracy of all persons tested, moreover, is 70%, A may be regarded as of super-normal acuity, and B as of sub-normal acuity. The theoretical superiority of this method is supplemented, too, by certain experimental results which, while not furnishing final proof, do in certain instances point toward the correctness of this method. These are given in the appendix.

Summary of Speech Tests. This discussion of speech tests has urged their importance as the only unequivocal measure of the ability to hear speech. An analysis of speech into its elements (following Wolf), and an examination of the apperceptive conditions of audition, furnished the criteria by which the material for speech-tests was selected. Judged by these criteria, number-words were found to recommend themselves for use in tests. Ten comparable and equivalent lists of ten number-words each were selected. The general conditions of conducting speech tests were given, followed by a statement of two methods of testing: the first, the common method of measuring the individual's acuity in terms of his extreme range of audition; the second, a proposed method of pronouncing all the test-words at one or more common constant ranges, and determining the individual's acuity in terms of the percentage of accuracy of audition.

B. Tests of Acuity of Hearing with Tones and Noises.

While speech tests alone measure unequivocally the ability to hear speech and, therefore, are to be employed, if possible, to determine acuity of hearing, limitations of space and other difficulties of using speech tests will often require the employment of tests with mechanically produced sounds. Reserving for a later section those methods which have their particular significance in the diagnosis of aural dieases, we will consider here, I, the four chief methods of testing acuity of hearing with mechanical sounds,—(*a*) with the watch, (*b*) acoumeter, (*c*) audiometer and other electrical devices, and (*d*) with forks; II, the tests of the lower and upper limits of tonal audibility.

I. Tests of Acuity of Hearing. It is a familiar fact that individuals vary in sharpness of hearing. Hard-hearing is an almost invariable accompaniment of old age,[1] and many individuals, young and old, have sub-normal keenness of hearing through innate conditions, or as a result of disease. The disturbance ordinarily manifests itself in difficulty in conversation, though, if the deficiency is slight, the person affected and his friends may alike be ignorant of its existence. The detection of such cases is particularly important in the public schools, where pupils who are regarded as stupid are often only hard of hearing, and could be properly provided for by advantageous seating and other special attention; were the real nature of their trouble understood. Tests of auditory acuity should also be applied to railroad men, telegraph and telephone operators, the police, soldiers, and all individuals in public or private service of a nature that demands accurate audition. In part, speech tests can be used for the purpose; but tests more convenient of application are often demanded, even if their results are not so unequivocal. Further, tests of finer adjustment than speech tests are needed to detect slight reductions in acuity of hearing or slight improvement in cases under treatment.[2] The tests with mechanical tones and noises meet these requirements. We shall consider several such tests in order.

A. Watch Test. This has long been the most common test of hearing and is still the one most frequently used in medical practice. The objections to the watch test have already been partly set forth in treating speech tests. Its results are not a

---

[1] Bezold's results give a comparison of hearing in school-children, and in persons over fifty years of age, as follows: 46.5% of the school-children examined had a range for whisper-speech of 16 m. or more; only 15.57% of persons fifty to sixty years old had a range of 8 m. or more, and only 6.7% of those from sixty to seventy had this range. Not only is there a decrease in acuity in old age, but the decrease becomes relatively more rapid as it proceeds. *Funkt. Prüf.*, 152-154.

[2] Politzer: *op. cit.*, 110.

reliable indication of the capacity to perceive speech; its sounds are a series of equidistant tones (Wolf) and so give rise to a perception of rhythm, not of simple sound; its ticking is so familiar that illusions of hearing are very frequent, *i. e.*, the subject imagines he hears the watch and reports it as heard even when it is beyond range; watches vary in the quality and intensity of their sounds, and hence results are not directly comparable.[1] On the other hand, the watch is always at hand and convenient to employ, and the procedure can be so arranged as to resolve, in part, the objections just stated. Nevertheless, the objections stand in part, and the writer recommends strongly that the watch be used only in cases where more accurate and standardized instruments cannot be secured.[2]

The procedure for watch tests consists essentially in determining the last point at which the ticking can be heard as the watch is carried out from the ear; then, after passing beyond the audible range, the watch is brought in toward the ear until again heard; the average of the two distances at which it is just heard is the range for the ear tested. The details of procedure may be stated as follows:

1. A range should be chalked on the floor 9-10 meters long, marked with half-meter sub-divisions from the one-meter point on. The meter stick itself should be used for distances less than a meter, being held for this purpose at right angles to the ear, and the watch moved along it. The range should extend along the middle of the room, and, as in the speech tests, the subject should be seated.

2. The subject's eyes should be kept closed, or better, covered with a blind. If he carries a watch, it must be laid aside. Quiet must be observed within and about the room.

3. The watch should be carried out along a line at the level of the ear and a little forward of a line passing through the two ears. It should always be held in the same relative position, preferably with its face toward the ear tested.

4. Tests should be made at the half-meter points along the range till a point is reached at which the ticking is no longer heard. The procedure is then reversed, and the watch brought in by stages, until again heard. The average of the two values is the range for the ear tested.

---

[1] F. Bezold states fully the objections to the watch in *Archives of Otology*, xv, 1886, 79; and on p. 9 of *Das kindl. Gehörorgan* gives comparative results showing the discrepancies between watch, acoumeter and speech tests. The acoumeter and voice agree better than the watch and voice. *Cf.* Tafel I, opp. p. 94, *op. cit.*

[2] Cattell and Farrand used the stop-watch (*Psych. Rev.*, iii, 635). It is also recommended by the Committee on Tests (*ibid.*, iv, 134). An ordinary watch, however, will serve as well if a stop-watch is not at hand. Stop-watches have been suggested by some with the method of stopping and starting the watch and requiring the subject to tell how many times he hears the watch going. The click made in starting and stopping most stop-watches is so loud, however, that the method is useless. This method can be used with an ordinary watch by covering and uncovering it in the hands.

5. Check tests should be constantly interpolated, especially with children, by covering the watch with the two hands and then asking if it is heard. This will disclose illusory judgments.

6. Each ear is to be tested separately, the other being meantime securely closed.

7. A normal range must be determined for the particular watch used. This can be taken as the average of a large number of individual determinations, and will vary with different watches. The hearing acuity of an auditory organ is then expressed as a fraction, whose numerator is its range, and whose denominator is the normal range; *e. g.*, if the average range is 2 m. and A's left ear has a range of 1.5 m., its acuity is ¾ normal. Expressed in such a way, the results of different investigators using different watches can be compared.

B. Acoumeter Tests. Dissatisfaction with the watch as a means of testing led Politzer to invent a small instrument, the acoumeter, which could be used as a substitute.[1] It consists of a small steel cylinder fastened at right angles into a hard-rubber upright, with a percussion hammer which can be raised a constant distance and allowed to fall upon the cylinder. This gives a tone (c^2), uniform in pitch and intensity. The instrument as described is arranged for air-conduction. It is also provided with a metal disc which can be set directly against the temporal bone, mastoid process, or other parts of the skull, if it is desired to test hearing with bone conduction. The general procedure with the acoumeter, and the conditions to be observed, are precisely the same as in the watch test, and in making tests, reference should be had to the statements given in the preceding sections. In addition, the following points should be observed.

A large room will be needed for testing, for the instrument has a normal range of 15 m., which extends for very keen ears to 20 m. or more. The acoumeter must always be held perpendicular in giving the stimulus. The "ready" signal is given before each test, and fatigue avoided by allowing a short interval between successive tests, and limiting the length of a series. The actual procedure, in the receding series, consists of giving a varying number of acoumeter tones (1, 2, 3 or 4) at the successive points on the range, 10 m., 10.5 m., etc. The subject each time reports the number of tones he hears. The receding range is that at which he last reports correctly the number of tones given. The approximating series is made in a similar way, by starting at a point at which the sounds are inaudible. The range at which there is the first accurate report of the number of tones given, is the approximating range. The two are averaged for the range of the ear under test. The normal range is taken as the average of the various individual ranges, as with the watch, and the acuity of an individual ear is expressed as a fraction whose numerator is the range for the particular ear, and whose denominator is the average range; thus the results of various investigators are made comparable.[2]

---

[1] Politzer: *op. cit.*, 107-8.

[2] Politzer and others give the normal acoumeter range as 15 m. Bezold's results (*Das kindl. Gehörorgan*, 7) indicate a normal range of 16 or 17 m. This emphasizes the necessity of computing the normal

The acoumeter gives a more reliable measure of relative acuity for hearing speech, than does the watch.[1] It is, therefore, to be recommended instead of the watch. Its range is approximately the same as that for whisper-speech, and accordingly it has no advantage over speech tests in the space required for its employment. It should be borne in mind that the ranges of hearing with the watch, acoumeter, audiometer, etc., have no psychological significance, and are not to be confused with psychophysical limens.

C. The Audiometer and other Electrical Devices. Many attempts have been made to adapt electrical devices as testing instruments. The general plan has been to use a telephone click which will vary in intensity according to the amount of electric energy employed in producing it. The amount of current so used has been varied by a sliding induction coil, or by adjustable resistance, and admits, of course, of ready measurement. This, in turn, evaluates the intensity of the sound produced. Hughes and Boudet, Hartmann, Blyth, Koerting, Urbantschitsch, Preyer and others have devised and used various instruments of this sort.[2] Politzer makes the general objection that such instruments do not provide accurate measurement of sound intensity. This difficulty is apparently resolved in an audiometer recently devised by Seashore.[3]

This instrument gives a double telephone click, whose intensity can be varied through forty stages which are approximately equal in consciousness. The instrument includes a dry battery, primary coil, variable resistance coil, variable secondary coil, and a galvanometer, with necessary switches and wires leading to a telephone receiver. The primary current, by means of the variable resistance, can be adjusted to remain at a certain constant amount. The induced current may be varied in intensity through the forty steps, which furnish a measure of the intensity of the click given in the receiver on making and breaking this current. This instrument can be used with limited floor space, and outside noises give less disturbance than with most testing methods. An ascending and a descending series of tests are made, and the results averaged. Check tests should be inserted, especially when near the limen of hearing, by giving the "ready" signal and then omitting the stimulus. The two sounds produced by the Seashore audiometer are not, at least not always, alike in quality. This objectionable feature could doubtless be eliminated by a modification of the apparatus. The results are in terms of the arbitrary scale of forty steps in intensity; but they can be transposed into a more comparable

(average) range for the particular instrument used, and the particular conditions of each test. Politzer calls attention (109) to variations in individual results on different days, at different hours of the day, and under different physical and mental conditions (fatigue, anxiety, inattention, etc.). These facts should be remembered in employing the acoumeter, and, indeed, in all testing.

[1] Politzer: *op. cit.*, 109; Bezold: *op. cit.*, Tafel I, opp. p. 94.

[2] Gruber: *Diseases of the Ear*, 131; Politzer: *op. cit.*, 110.

[3] For a full description, see *Univ. of Iowa Studies in Psych.*, II, 158. This instrument is sold by the Chicago Laboratory Supply Co.

and intelligible form by writing them as fractions of the normal (average) result given by all the individuals tested.[1] The audiometer is also arranged to give a tonal stimulus. The tone may be varied and measured, Seashore says, in the same way as the noise stimulus. The author has not had an opportunity to test the audiometer in practical work.

D. Acuity Tests with Forks. The tuning fork is not adapted for acuity tests based on the distance at which a tone can be heard, since the tone given by a fork sounds first at a high intensity and then gradually "dies off;" when first struck, accordingly, it can be heard at a greater distance than a moment later when its tone has partially rung off. Van Conta[2] proposed a temporal method for forks which compares the ringing-off time for the ear under test with that for another ear used as a standard. It is based on the fact that the greater the acuity of hearing, the longer the tone will be heard.

A tuning fork (c^1) is struck and brought before the ear to be tested and when no longer heard, is transferred to the examiner's ear and the time it continues to sound noted. If necessary the procedure is reversed: the fork is placed first before the examiner's ear, and then before the ear under test. The obvious error in the variable time consumed in transferring the fork is avoided by Urbantschitsch, who uses a T-shaped tube with one branch in the subject's and one in the examiner's ear. The fork is held before the free end of the tube. By the use of two stop-watches each person can indicate accurately the length of time the tone is heard. There remains the error due to varying initial intensities of the tone, which can be reduced, but not eliminated, by care in striking the fork. This test obviously has a limited application.

II. Tests of Upper and Lower Limits of Hearing. Tonal sensations are evoked by the impact of periodic sound-waves upon the organ of hearing. Air waves of less than a certain minimal frequency do not produce a tonal sensation; similarly, air waves of more than a certain maximal frequency do not give rise to tones. We shall consider tests measuring the individual's upper and lower limits of tonal sensation. Such tests cannot pretend to the nicety of method or accuracy of results aimed at in psychological determinations. It is possible, however, to make rapid approximate measurements which will reveal individual variation in these capacities.

A. The Lower Limit of Tonal Sensation. Two distinct paths have been followed in determinations of the lower limen: it has been approached by trained investigators with skilled observers, and all the niceties of scientific method; so we have

---

[1] *Child Study Report, No. 2, 1899-1900, Chicago Public Schools,* gives results from testing 5,706 pupils with the audiometer. *Cf.* pp. 60 ff. See also *Some Results of Hearing-Tests of Chicago School Children*, D. P. MacMillan, *Medicine*, April, 1902.

[2] *Archiv f. Ohrenheilk.*, I, 107.

the work of Helmholtz, Wundt, Preyer, Appunn, and others who have secured results varying from 8 to 28 vibrations as the lowest audible tone.[1] Measurement of the lower limen has also been used in otological practice and in tests by Bezold, Zwaardemaker, and others, upon patients and other persons who are without training in scientific observation, and who present all extremes of general intelligence. Our proposed test plainly falls in with the latter rather than the former class. Of the instruments used in lower liminal determinations, the lamella and the wire forks are the most practicable for widespread use in tests. Testing methods will be stated for these two instruments.

(*a*) The lamella consists of a long, thin, steel blade, 420 mm. by 12 mm. by 1 mm., with a metal disc at its upper end. It is clamped in a wooden vise which in turn is fastened to a table. The lamella has a scale marked along one face showing the point to which it should be inserted in the vise to give 4, 6, 8, 10, ... 24 vibrations per second. When clamped in position at the desired point on its scale, it is put into vibration by springing it from a position of equilibrium with the finger. Thus sound waves of from 4 to 24 vibrations a second can be produced. Overtones are eliminated by adjusting a band of cloth one-third of the distance from the upper end of the blade.

There are two sources of error. (I) An error of observation. The subject is likely to mistake the discrete puffs of air at the lower rates for tones (Bezold). Practice should be given with a few preliminary tones at the higher rates which are usually clearly distinguished as tones, and then with the lowest rate which will give discrete puffs of air, and the subject's attention called to their qualitative difference. (II) An objective error. The length of the lamella increases as the tone deepens, and hence the amplitude of vibration and the intensity of the tone increases (Zwaardemaker). This cannot have much weight, as the difficulty of perception increases as the tone deepens, and the facility due to increased intensity may be regarded as an offset to the greater difficulty of perception. The procedure with the lamella involves the usual ascending and descending determinations and an averaging of results.

(*b*) The Appunn wire forks are made of wire bent in the usual fork form, and provided with discs on the ends of the prongs. The series includes forks differing by two vibrations from eight to twenty-four vibrations, and by eight vibrations from twenty-four to fifty-six vibrations. These forks present the following advantages: approximate freedom from overtones;

---

[1] Helmholtz used organ pipes and a vibrating monochord: *Sensations of Tone*, 1895, 175-6. Preyer used reeds and a heavily weighted fork: *Die Grenzen d. Tonwahrnehmung*, Jena, 1876. Wundt used the heavy fork, the Appunn lamella or vibrating blade, and difference tones: *Grundzüge d. phys. Psych.*, 4th ed. I, 450; other investigators have used Appunn's wire forks.

tones loud enough to be audible; the initial amplitude is constant for each fork; they are easily handled, and present no serious difficulties for untrained subjects. The series should be applied in both orders, and an average struck between the results.

With the lamella, Zwaardemaker found average values for the lower limen for different ages at from 10 vibrations to 13 vibrations.[1] Bezold, working with loaded forks (Edelmann's), uses a lower limen of 16 vibrations, though for many persons, he says, this doubtless lies above the actual limen. The general results of tests will probably agree more closely with Zwaardemaker's figures.

B. The Upper Limit of Tonal Sensation. The most practical instrument for upper limit tests is the Galton graduated whistle. This was invented by Francis Galton and has been recently improved by Edelmann.[2] It consists of a covered cylindrical organ-pipe of small dimensions with a small air-bulb as bellows. The pitch of the whistle is varied by a micrometer screw which moves a piston up and down the cylinder, thus altering the length of the pipe. Readings on the micrometer scale correspond to the pitches to which the whistle can be adjusted. As modified by Edelmann, it has a second micrometer screw which adjusts the lips of the whistle to give an optimal tone at the various pitches. A schedule accompanies each instrument showing the proper setting of the two adjustments for the pitches within its compass. One form covers the tonal scale from a^4 of 3,480 vibrations to f^8 of 44,193 vibrations and above that to 49,000 vibrations. A scale of

[1] A. Zwaardemaker: *Zeitsch f. Psych. u. Phys.*, vii, 1894, 10. Zwaardemaker in this article attempts to establish a correlation between increasing age and a shortening of the tonal scale. The average lower limit for ten to twenty years is 10.10 vibrations; for thirty to forty years, 10.85 vibrations; over sixty years, 12.95 vibrations. Tonal audition extends over eleven octaves in youth, he concludes, and only ten octaves in old age. He reached these results with the lamella and the Galton whistle. Bezold (*Funkt. Prüfung*, 144), using the weighted forks and the whistle, finds that the shrinkage is much less, and explains it as due to injuries and disease, rather than advancing age.

[2] Determinations of the upper limit have also been made in the past with small forks, made by Appunn, Koenig, and Edelmann, and with Koenig's cylinders. Appunn's forks consist of one series of eleven forks, varying by steps of 5,000 vibrations, from 5,000 to 45,000, and another series of thirty-three forks from c^4 (2,408 vib.) to g^8 (49,152 vib.). Discredit has been thrown on determinations with Appunn's forks through recent investigations showing large errors in their vibration markings. (For statement of discussion see *Zeitsch. f. Psych. u. Phys.*, xxi, 141; xxii, 229; xxiv, 171 and 367.) Koenig's cylinders are of steel, 20 mm. in diameter, and of varying length. One set of ten cylinders covers the range from 4,096 to 32,768 vibrations. There is also another series of 22 cylinders covering the same interval.

intervals by steps of 1,000 vibrations is also usually given, from 10,000 vibrations to the upper limit. Zwaardemaker notes two advantages of the whistle: it is approximately constant in intensity,[1] and its tone is prolonged but an instant, and so does not fatigue the ear. Further, it may be said that the whistle is simple to operate, and gives a tone which when present is not difficult to distinguish from the accompanying noise. In testing with the instrument, an ascending and descending determination should be made and averaged. Checks should be made on judgments at the limen, by interpolating occasional pure noises between the tones. Results may be expected to vary considerably; it should be remembered that large differences in vibration rates at 30,000 to 50,000 vibrations mean only a small tonal difference; *e. g.*, the interval just stated, which comprises 20,000 vibrations, is only a major 6th.[2] Perception at the upper limen is very fatiguing, and series must accordingly be limited.

APPENDIX.

AN EXPERIMENTAL EXAMINATION OF SPEECH-METHODS.

We have given in the text what may be called the 'traditional' method of testing audition by means of speech. This method, it will be remembered (see p. 40), is the method of Extreme Range of Hearing. A normal maximal distance is selected and, on the basis of it, individual capacities are computed by comparing the individual ranges with the normal range. Thus, if the normal range is twenty meters and the individual's limit falls at ten meters, the individual's capacity is represented by some fraction · *e. g.*, ½.

Now it is evident that the correlation of auditory capacity with distance will be valid only on condition that distance and audibility stand to each other in some simple functional rela-

[1] E. W. Scripture: *Studies of Yale Psych. Lab.*, II, secured constant pressure by mechanical means. See, however, Myers' results in the next foot-note.

[2] Edelmann gives 50,000 vibrations, or g^8, as the upper limit; Schwendt, e^8-f^8 (41,000-44,000 vibs.); Zwaardemaker, with persons of all ages, from c^6 to f^7 (22,000 vibs.). For Edelmann, see *Zeitsch. f. Ohrenheilk.*, xxxvi, 1900, 330; Schwendt, *Pfluger's Archiv*, lxxv, 346, lxxvi, 189, and *Archiv f. Ohrenheilk.*, xlix, 1; Zwaardemaker, *Zeitsch. f. Psych. u. Phys.*, vii, 10. Very recent determinations by C. S. Myers (*Journal of Physiology*, London, xxviii, 1902, 417-425) throw doubt on all high results with the Galton whistle. Myers concludes that the pitch of the whistle varies with the absolute air pressure and with changes in air pressure; and that the liminal value of 50,000 vibs. is unreliable. He puts the limen at 20,000 to 25,000 vibrations for young adults. Tests may be expected to give results like Zwaardemaker's and Myers', *i. e.*, about 20,000 vibs.

tion, and further, on condition that the sounds used as test-words undergo, with change of distance, merely a quantitative, not a qualitative, alteration. These conditions have been assumed, without sufficient ground, by the traditional method.

The obvious way to test these assumptions is by appeal to experiment. Two groups of experiments were, accordingly, arranged and carried through in a manner presently to be described. In the first group, a large number of ranges was employed as a preliminary step to the selection of a final, maximal range, as provided for by the method. These experiments brought to light the fact that the two essential conditions just named are not to be found in the method as it stands.

The second group had, then, for its end the discovery of a more adequate mode of procedure.

I. *Preliminary Tests for the Determination of Extreme Range.* The experiments in Group I were conducted in the Armory Hall of Cornell University, a rectangular room 40 by 120 feet. The range began at a point twenty feet from one end of the room, and was laid off along the median line for a distance of eighty feet. The person giving the test-words stood at the zero point of the range, while the observers took up their positions, 20, 30, 40, . . . 80 feet, along the line indicated. A Table of tests, consisting of ten series of ten number-words each, was compiled.[1] These series were given at the various points along the line, and the subjects wrote down the numerical symbols of the words so far as they were heard. Results were computed on the basis of percentages of accuracy in each series, part credit being given where syllables, and not whole words, were heard correctly. There were ten observers. They are indicated in the Tables by the letters A, B, ... J.[2]

---

[1] These words (the original lists devised by the writer) were as follows:

I. 6, 42, 87, 34, 29, 61, 94, 18, 70, 53; II. 92, 33, 12, 75, 5, 27, 8, 69, 47, 50; III. 19, 28, 35, 60, 51, 86, 3, 98, 79, 45; IV. 96, 20, 41, 15, 89, 72, 57, 38, 2, 65; V. 13, 25, 46, 32, 7, 83, 68, 54, 73, 90; VI. 31, 4, 23, 14, 48, 67, 85, 91, 52, 76; VII. 37, 26, 49, 8, 66, 17, 74, 58, 93, 82; VIII. 81, 22, 13, 6, 30, 78, 64, 97, 44, 55; IX. 62, 43, 39, 84, 14, 56, 7, 99, 21, 77; X. 3, 40, 95, 36, 16, 59, 10, 63, 24, 71.

Like the revised lists given in the paper, these series are comparable as regards the relative frequency of low, medium, and high consonants (Wolf's classes). They are not exactly equivalent, however, in point of primary number-words present in each. After using them in the first part of the experiments, revised series (p.36), which met precisely this second criterion of equivalence, were substituted.

[2] The subjects, whose assistance the author takes this occasion of acknowledging, were Professor I. M. Bentley and Dr. J. W. Baird, of the Department of Psychology; Messrs. R. B. Waugh and W. A. Frayer, who had had some training as observers in psychological work; and Messrs. R. W. Palmer, L. E. Palmer, T. E. Faxon, G. L. Genung, C. L. Rand, and R. G. Marvin.

Table I gives the average (percentages) of accuracy for each individual at the various ranges at which he was tested. Each percentage is the average of accuracy for all the series used with a given individual and for a single distance. The figure in parenthesis after the percentages indicates the number of series on which the average is based.

TABLE I.

Range in feet	20	25	30	40	50	60	65	70	75	80
Person										
A.			75.0(3)	60.0(3)	51.6(3)		33.0(6)		32.5(2)	38.3(3)
B.	90.0(1)	95.0(1)	79.2(5)	73.7(4)	68.7(3)	61.1(1)	28.2(5)	55.4(3)		47.5(6)
C.	90.0(1)		66.2(4)	56.2(6)	66.2(1)	43.7(1)	35.0(6)	40.0(1)	38.7(2)	29.6(4)
D.			62.5(5)	56.1(5)	47.5(5)	52.5(2)	47.5(2)	42.5(2)		
E.	95.0(1)	72.5(1)	71.2(2)	47.5(3)	36.4(5)	46.2(1)	53.7(2)	42.5(1)		37.9(3)
F.	97.5(2)	55.0(1)	83.7(1)	65.0(1)	66.2(1)	66.2(1)		47.5(1)		41.2(1)
G.			45.2(5)	38.1(5)	46.6(6)	40.0(2)	33.7(2)			
H.	65.0(1)	55.0(2)	48.7(1)	52.5(1)	60.0(1)	37.5(1)		37.5(1)		42.5(1)
I.	83.7(3)		65.0(1)	60.0(1)	86.2(1)	27.5(1)		30.0(1)		32.5(1)
J. (deaf ear)	23.7(1)		15.4(3)	2.5(1)	10.0(1)	5.0(1)		0.0(1)		0.0(1)
Totals. (A-I)	87.36	66.5	66.14	55.00	53.30	46.70	35.50	45.1	35.5	37.30
M. V.	10.2	21.2	12.7	9.4	11.9	10.0	10.1	7.6	4.3	8.2

This Table indicates, from the standpoint of individual results, that while there is a general decrease in audibility as the distance increases, yet the decrease is neither constant nor uniform. For example, the percentages for A and B show a fairly uniform decrease through the middle ranges; but there is an unexpected rise in the figures at the 80-foot range. This inequality is due, apparently, to reflection of sound-waves from the farther end of the room—a factor which makes results at the longer ranges of this particular room difficult of interpretation. The results indicate, further, that not only are the changes in intensity of sound not uniform as the range increases, but that over a considerable middle part of the range the intensity of the sounds may be approximately constant, so that differences in distance do not give corresponding differences in intensity. See, for example, the percentages of C and G at 30, 40 and 50 feet; or of E at 40-65 feet.

We are aware of the possibility of error in these conclusions due to the small number of cases considered; particularly, since the test-series used in this part of the experimental work lack perfect equivalence. Whatever influence might arise from either of these sources, however, would scarcely be felt in the

averages for observers A—I, which are given at the bottom of the Table.

The lack of uniformity, both in the individual and the general averages, suggests strongly the limitations—not to say the inadequacy—of the commonly accepted method of speech tests—the method of extreme range of accurate hearing. It shows that, under the given conditions, there is no simple relation between length of range and the goodness of hearing. Over and above these general results, the tests just considered throw some light upon the relative ease of perception of the various elementary number-words which make up our lists. Table II shows the percentage of accurate audition for each syllable at four of the ranges. The last column gives the percentage of right cases (sounds heard correctly) for each syllable at all distances. The total number of syllables recorded was twenty-five hundred.

TABLE II.

RANGE	30 Feet.		50 Feet.		65 Feet.		80 Feet.		All ranges.	
	WORD	% R	WORD	% R	WORD	% R	WORD	% R	WORD	% R.
1st	twen	96.4	six	87.9	six	86.0	six	92.3	six	90.4
2nd	six	94.9	-ty	80.0	seven	71.1	-ty	66.6	-ty	76.7
3rd	ty	89.4	eight	77.5	-ty	64.9	two	61.9	seven	70.2
4th	eight	79.4	twen	71.4	two	57.1	seven	57.1	twen	68.0
5th	seven	79.2	seven	70.7	twen	54.5	twen	36.8	two	64.6
6th	nine	68.9	two	70.3	eight	41.3	three	25.0	eight	58.7
7th	two	66.6	-teen	48.1	nine	22.5	eight	22.8	-teen	38.6
8th	one	65.0	one	42.8	five	13.0	-teen	22.2	nine	37.8
9th	thir	58.8	three	40.9	three	12.5	four	19.0	one	34.2
10th	-teen	57.6	thir	38.8	-teen	11.7	five	16.29	thir	32.4
11th	five	47.8	five	38.6	four	6.9	thir	13.6	five	31.8
12th	four	45.6	nine	32.0	one	6.6	one	11.7	three	25.8
13th	three	25.9	four	19.6	thir	0.1	nine	9.6	four	22.8

In this Table, "one" is heard moderately well throughout the shorter ranges and poorly at the longer. "Two" holds a fairly constant position, at 60%-70%. "Four," which has a medium audibility at thirty feet, drops at the longer distances. "Five" holds its medium place up to fifty feet, but falls later. "Six," on the other hand, maintains a high place throughout. Similarly, "Seven" keeps a high position, though it drops off a little at the longest range.

One may say, in general, on the basis of the Table, that (1) there are distinct differences in the ease of audition for the different number-syllables; although (2) these differences are not constant throughout the various ranges. It is obvious, *e. g.*, that 'six' and 'ty' are better heard, at any one of the distances used, than 'four' and 'five;' but it is also obvious that the

advantage which one syllable has at, say thirty feet, may be transferred to another syllable at sixty-five or eighty feet.

This rise and fall of syllables in the Table is significant. If change in distance at which a sound is heard means simply alteration in intensity, then all words should suffer the same fate, as the range is increased; but if the phonetic elements undergo change by reason of re-enforcement and absorption, then we should expect to find precisely what, as a matter of fact, we do find in our results. We find that 'twen,' *e. g.*, falls from ninety-six to thirty-seven percentage of right cases where 'two' falls only from sixty-seven to sixty-two. The one syllable suffers rapid dissolution; the other is heard practically as well at eighty feet as at thirty. Other similar comparisons may be drawn.

We may say, in concluding this section, that the distribution of 'right' cases — whether we consider gross averages of series (Table I), or averages for individual phonetic elements (Table II) — shows that the physical conditions under which the experiments were made were too complex and too variable to give a definite and unambiguous measure of auditory acuity in terms of distance. Any test which, like ours and like speech tests in general, involves reflecting and absorbing surfaces complicates hopelessly both the absolute intensity and the qualitative integrity of the sounds employed and, therefore, violates conditions which we found at the beginning of this section to be indispensable to the success of the method.

II. *Method of Degree of Accuracy*. The root of the difficulty in the method just criticised lies in its attempting to measure audition in terms of a 'normal' distance where no 'normal' distance can be secured. It should, however, be possible to save a remnant of the traditional method by making — not distances[1] — but the number of right cases at *a given constant distance* the basis of computation. This modification we have attempted to carry through in the experiments now to be described.

The second group of experiments was performed, for the most part, in two suites of rooms in the psychological laboratory, at Cornell University. One suite, here designated "A," consisted of a lecture room 24 by 42 feet, adjoining which, by a door near one corner, was a small room 12 by 22 feet; the subjects were seated in the corner of the room diagonally opposite the door, and the range was laid off along the diagonal. The experimenter occupied three constant positions, two on the diagonal, giving a 20-foot and a 40-foot range, respectively,

[1] Various distances are used in the following experiments, but only by way of finding the most convenient conditions under which to work.

and a third position, ten feet away from the diagonal and within the smaller adjoining room. This gave three constant ranges of 20, 40, and 50 feet, in room A. The second suite, "B," was quite similar except in size; the large room was 42 by 18 feet, and the small room 8 by 20 feet. The range extended along the median line of the large room to a 20-foot and a 40-foot point, and from the latter at right angles through an open doorway to a 55-foot point in the smaller room. Room "B." had, accordingly, three constant ranges, 20, 40, and 55 feet. The two rooms, "A" and "B," from their size and the different location of the ranges, may be regarded as distinctly unlike as regards acoustical conditions.

The method consisted in submitting to the subjects a series of ten words at 20 feet, a second series at 40 feet, a third at 50 feet, and so on until all ten lists were given, distributed in each case as follows: three lists at 20 feet, three lists at 40 feet, and four lists at 50 or 55 feet (according as the tests were in room "A" or "B"). Only one ear at a time was used.

TABLE III.

			20 Feet.		40 Feet.		50 Feet in A. 55 Feet in B.	
Obs.	Room	Ear		M. V.		M. V.		M. V.
K	A	L	80.5	9.2	85.7	5.3	46.2	13.3
		R	66.1	2.7	83.3	2.2	43.3	5.0
	B	L	91.6	3.9	90.2	3.5	54.3	7.4
		R	91.1	6.3	83.3	5.0	66.6	8.3
			82.3	9.0	85.6	2.3	52.6	7.8
L	A	L	86.9	8.3	86.6	8.9	65.1	10.2
		R	86.1	2.6	90.0	6.7	56.6	9.1
	B	L	87.2	9.2	92.4	3.3	61.8	9.3
		R	94.4	5.2	95.5	2.9	73.3	8.3
			88.6	2.8	91.1	2.8	64.2	5.0
M	A	L	72.2	4.1	82.2	5.9	60.0	4.2
	B	L	90.0	4.4	85.0	5.5	57.9	5.4
			81.1	8.9	83.6	1.4	58.9	1.0

Table III includes results from two sets of experiments carried out in rooms "A" and "B." Reading the tables horizontally, one gets the percentage of correct cases for series of ten words each,[1] at a given range. The letters A and B in the

[1] Most of the results are based upon twenty series for each line; a few upon ten series.

Table designate the rooms used for the particular series of tests; K, L, and M, the observers.[1]

Assuming an acoustical difference in the two rooms, "A" and "B," we might expect, if our method is sufficiently delicate, to find some indication of it in comparing the results of similar tests given in the two rooms. Now the results do show higher average, range for range, for both the right and left ear, in room B than in room A. There are only two places in which B gives slightly lower averages than A, and there the range is 55 feet as against 50 feet in A. There is, accordingly, practical uniformity of higher averages for B than for A. This can only be accounted for as due to better acoustical conditions in room B. But it is fair to maintain that since the proposed method is precise enough to reflect in its results such acoustical differences, its delicacy, in actual tests of auditory capacity, is assured.[2]

But the most important issue of the method appears when we compare observer with observer within the same room and at the same range. Here we come to the real test of the method. The following Table gives the order, from worst to best, of the three observers and over the three ranges.

TABLE IV.

	Room	20	40	50 and 55
Left Ear	A	M, K, L	M, K, L	K, M, L
	B	L, M, K	M, K, L	K, M, L
Right Ear	A	K, L	K, L	K, L
	B	K, L	K, L	K, L

We find in the Table that, at the fifty and fifty-five foot ranges, the order for the observers is invariable. With both ears and in both rooms L hears with greatest and K with least acuteness. At the smaller distances, the order is not entirely constant. In considering the results, it must be borne in mind that no one of the observers is noticeably hard of hearing. We cannot expect, therefore, to discover large differences of capacity. It must be noted, further, that the small distances give percentages too near one hundred to be very significant. It is only where acuteness is considerably reduced—as it is in the last column—that we could expect to look for distinct and uniform differences. Where the method is used with marked im-

[1] These included the following Cornell students whose help is acknowledged with thanks. R. P. Butler, A. B. Truman, and O. Goehle.

[2] The fact that the forty-foot averages are higher than the twenty-foot is in striking confirmation of our contention regarding the effect of reflection upon intensity.

pairment of auditory capacity, we may expect still more striking and unambiguous results. To make sure of this, the writer tested three individuals, N, O and P,[1] whose respective ages were nineteen, thirty-five and sixty years and whose hearing was plainly different.

The experiments, which were carried out in two adjacent rooms in a dwelling, gave as an average of five series of ten words each and with a range of eighteen feet, the following percentages of right cases:

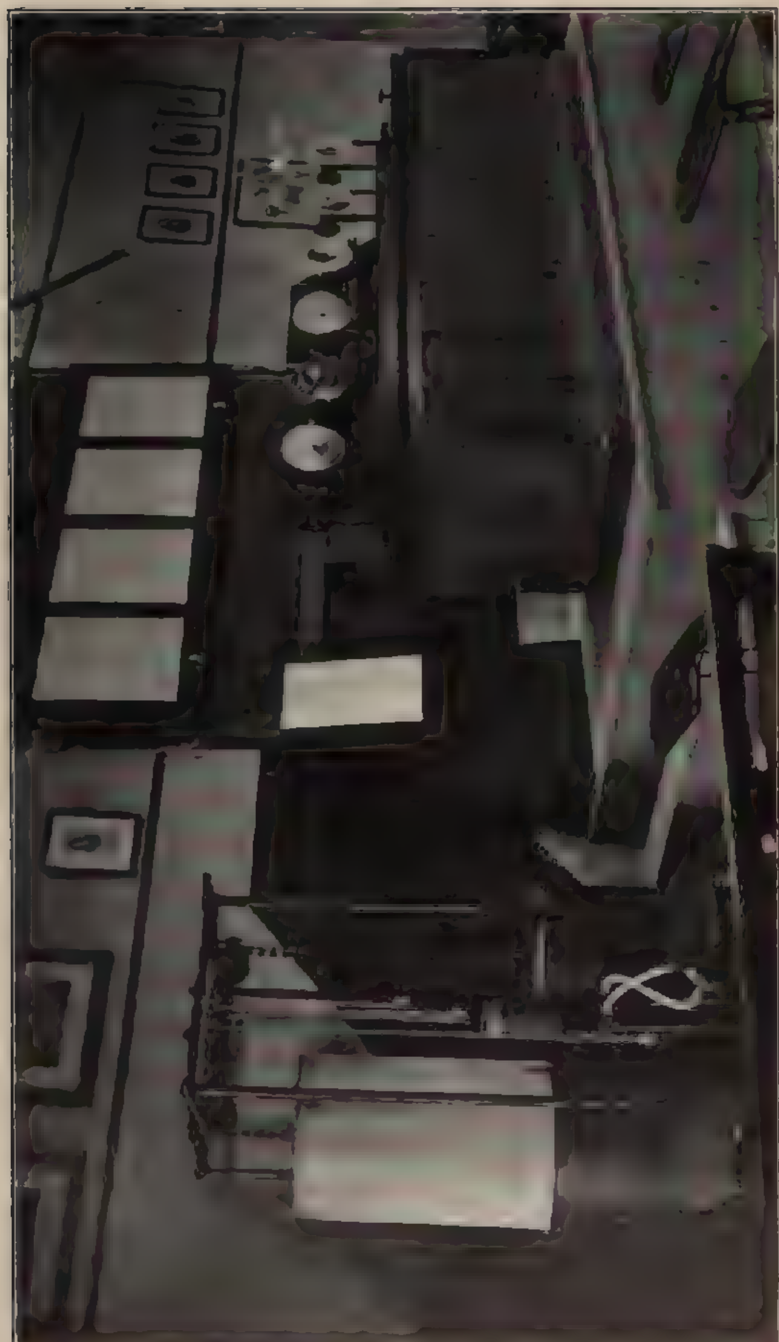
$N = 100 \pm 0$; $O = 80 \pm 7.3$; $P = 51 \pm 3$.

Even with so limited a number of results, we are safe in recommending the method of Degree of Accuracy. To be sure, it gives values which are valid only under the particular conditions of the experiments; but this is true, as well, of the method of maximal range which we have been obliged to discard as untrustworthy. Our own method, besides laying claim to vastly greater accuracy than the old method, is much more easily carried through, since it can be used in rooms of ordinary size,—the only necessity being sufficient space to give a fairly great number of incorrect answers. When once the proper range has been found, all other ranges should be discarded and the percentages reckoned on the basis of a single distance.[2]

---

[1] J. A., G. and C. T. Andrews.

[2] Experiments are under way in the Cornell Laboratory on a speech-method which will, if successful, eliminate entirely the factor of distance and provide a standard series of tests which can be employed without regard to local conditions.



SOME NEW APPARATUS.

E. B. TITCHENER.

In the last number of this *Journal* I described some apparatus for demonstration and class experiments.[1] Certain pieces were not completed at the time when that paper was written; so that I was not able to give illustrations. My present purpose is to make good this deficiency.

The accompanying half-tone plate shows four large apparatus, to which reference was made in my former paper.

1. *The new model Whipple gasometer.* The double gasometer for acoustic and general laboratory work was described and figured by Dr. Whipple in this *Journal*, XIV, 1903, 107 ff. A new model of the instrument is shown to the left of the accompanying plate. It has been rendered more compact, by the substitution of a metal for the original wooden frame. It has been mounted on a wheeled platform, so that it can be moved from room to room of the laboratory. Outlet cocks have been soldered into each tank, near the floor, so that the water can be drawn off and the apparatus correspondingly lightened for moving. The butterfly valves are encased, not in wooden boxes, but in felt-lined brass tubes. These can readily be taken apart if anything goes wrong with the flaps. Minor improvements have been introduced as regards the lateral guidance of the moving tanks, the overhead travelling of the chain, and the raising and shifting of the counterweight.

There is thus no change in principle, though the apparatus as a whole is a good deal more serviceable than it was in its first form. I may add that our inner stationary tanks have shown a tendency to rust into holes. We have learned wisdom by experience, and now keep some borax in solution in the contained water. The mending of a tank is, at best, an awkward business, and means the dismantling of at least half the apparatus.

2. *The frame for adaptation and after-images.* This is seen standing on the platform, to the right of the gasometer. The plate shows the frame in readiness for an experiment. The black-white sheet drops down, as was explained in my former paper, behind the black front, and exposes a gray sheet upon which the complementary after-images are seen.

---

[1] Commemorative Number, 175 ff; XIV, 1903, 439 ff.

3. *The contrast frame.* This is shown in place, upon the wall behind the lecturer's desk. The four colored papers are, from left to right, the Hering red, green, blue, and the Milton Bradley yellow. The gray strip is cut from Hering's gray paper, no. 11. The tissue paper front can be turned up, the colored papers and gray strip exposed, and the strip removed from the frame.

4. *The six-fold color mixer.* The mixer is also shown in place, upon the desk. The mechanism will be understood by reference to Fig. 1, which represents the parts at a quarter of their actual size.

a is the main frame of the mixer, made of cast iron. This is

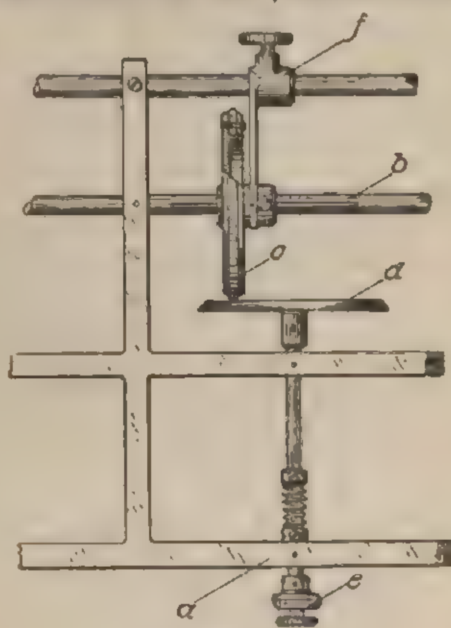


Fig. 1.

Detail of Color Mixer.

the cheapest material; and, with care, a good casting may be made. *b* is the main driving shaft, of wrought steel. It is driven by a motor, whose belt passes over the pulley shown at the extreme left of the instrument in the plate: the pulley may, of course, be placed at the center of the shaft, and the motor concealed beneath the lecturer's table, if desirable. The shaft carries *c*, the driving friction disc. This is made of alzinc, faced with leather. It actuates the driven friction disc, *d*, which is also of alzinc. It will be noticed that *d* tapers off at

the periphery, so that *c* can be brought on gradually, and metal strikes metal before the leather comes into action. As *d* turns, the spindle, carrying the clamp *e* for the colored papers, turns with it. *f* is the shifter, by means of which *c* can be set at any point upon the surface of *d*, or thrown off altogether. The remaining details of construction will be clear from the figure. It is evidently possible, while *b* is turning at a constant speed, to rotate the six color discs all at once at the same or at different speeds, or to rotate any one or more while the rest remain unmoved. The wooden base of the instrument stands upon a thick layer of felt, and the motor is set upon felt and boxed in: the noise may thus be reduced to a minimum. Even under the unfavorable conditions of my own lecture room — the desk acts as a resonance chamber, and the platform is built over a stairway and so acts as another — it is possible to continue lecturing, without strain of the voice, while the mixer is turning. The motor which we employ is a 1/6 H. P. Crocker-Wheeler ; a less powerful motor would answer as well.

5. *The wall campimeter.* This is not shown in the plate. I mention it again because, by some fatality, the dimensions were wrongly given in my previous paper.[1] A strip of 2 m. in length, as seen from some parts of the lecture room, would serve only to take the stimulus a short distance beyond the macular region. The strip is, in reality, 12 m. long; the stimuli are discs, 20 cm. in diameter; there are three fixation crosses, two at the two ends and one at the center of the strip. The best results are obtained with a dark violet disc, which shows in the blue-yellow zone as a hard, staring blue, and a bright reddish brown, which shows in the same zone as a clear yellow.

The apparatus could easily be made permanent. I would suggest two vertical spring rollers, fastened to the wall at either end of the lecture room, and carrying each 6 m. of cloth ; and a permanent wire, to be tightened by a ratchet, extending across the wall for the support of the upper edge of the cloth. The two strips of cloth could be hooked together where they meet, over the center of the blackboard; a draw-string along their lower edge would prevent curling. It would also be easy to devise a stimulus carriage, which should travel along wires from end to end of the cloth, and be operated from a single point by the lecturer. I doubt, however, from the partial estimates that I have so far made, whether the apparatus wo be worth its cost. The manila strip, and the rod and disc in the hands of an itinerant lecturer, satisfy all requirements.

6. *A disc cutter.* I mentioned in my former paper that we

[1] *Ibid.*, 185; XIV, 449.

have used, to construct color discs, two discs of copper, turned accurately to the right size, and pierced at the center. The paper is laid between the copper discs, which are clamped together, and is trimmed round the edge with scissors.[1] I found at the beginning of the current academic year that the copper discs had suffered a good deal from student usage; their edges were flattened and dented. It therefore seemed worth while to make a different and less damageable apparatus for disc cutting. We now employ the instrument shown, quarter size, in Fig. 2.

e is a circular base of hard wood. Upon it is screwed an aluminium disc, *a*, of the same size. The base is pierced at the

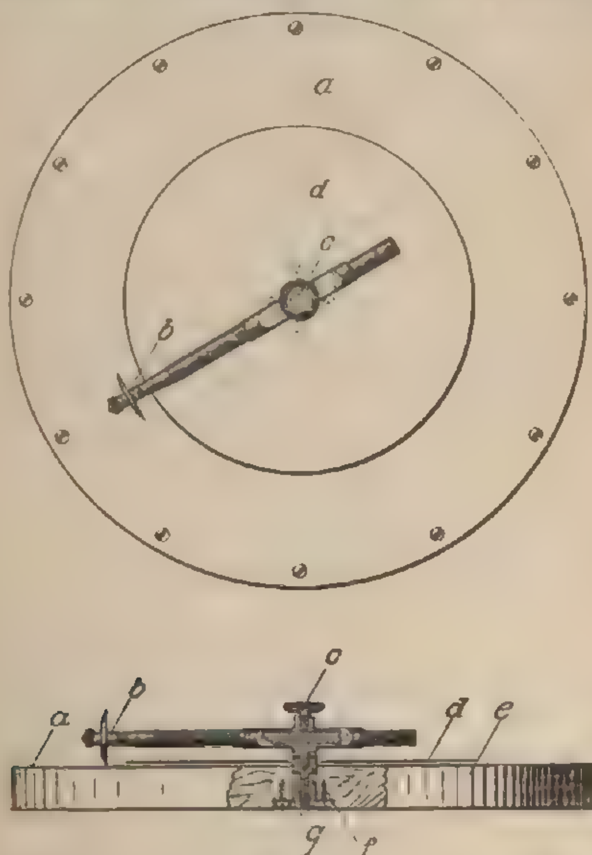


FIG. 2

Disc Cutter.

[1] *Ibid.*, 182; XIV, 446.

center by a screw post, *f*, which is held below by a split nut *g*. The top of the screw post is hollowed to receive a boss from the cross-arm which carries the knife, *b*, of tempered steel. The knife can be set for any required radius; the arm is held in place by the cup screw *c*. *d* is a loose disc of aluminium, fitting over the top of the screw post.

The top of the screw post is of the same diameter as the *large-sized* central holes of the Hering or Zimmermann discs. When a disc of this sort is to be cut, the paper is roughly shaped with scissors, and the central hole punched out. The paper is then laid on *a*; *d* is laid over the paper; the cross-arm is put in place, with *b* at the right distance from the center; and arm and knife are turned from *c*. The disc *d* serves to hold the paper flat for cutting. The boss that extends into the head of the screw post is of the same diameter as the *small-sized* central holes of the imported discs. When a disc of this sort is to be cut, the paper is shaped and the center punched, as before. Then *f* is turned down flush with the surface of *a* (there is a slot in the head of the screw post, not shown in the Fig., which takes the screw driver); the paper is laid over *a*; a small-holed *d* is laid over the paper; the boss passes down through *d* and paper into the head of *f*; and the cutting is done as before. It is thus necessary to have four *d*: two large, with large and small central holes, and two small, with similar holes. The instrument is cheap, strong and simple, and ought to last longer than the copper discs.

All the pieces here mentioned were made by Mr. F. A. Stevens, the mechanician of the Cornell laboratory. I am indebted to Mr. Stevens for many improvements of design and for suggestions as regards details of construction.

EBBINGHAUS' EXPLANATION OF BEATS.

I. M. BENTLEY and E. B. TITCHENER.

This paper grew out of a discussion between the writers of the theory of beats set forth by Ebbinghaus in his *Psychologie*. The discussion brought out the fact that certain aspects of the theory had been, if not differently understood, at least very differently weighted and estimated by two interested readers of the book. Further reading and discussion have led, first ; to an agreement as to the main features of Ebbinghaus' exposition, and secondly to the following joint criticism.

The paper is confined specifically to the subject of its title. The writers desire to insist upon this point, as it constitutes their apology for the neglect of many articles, etc., reference to which might, in view of the general topic, be expected by the reader.

THE HELMHOLTZ THEORY OF TONAL SENSATIONS.

According to the revised version of the Helmholtz theory, the basilar membrane may be considered as a system of stretched strings, in which every individual string moves in relative independence of all the others.[1] If a simple tone is struck outside the ear, its stimulus throws a part of the basilar membrane into sympathetic vibration. That fibre vibrates most strongly whose proper motion corresponds most nearly to the movement of the external stimulus. From this fibre the vibrations extend on both sides, with rapidly diminishing strength, to the adjacent parts of the membrane. The sympathetic vibration thus set up "is still sensible for the interval of a semitone."[2]

Helmholtz applies Johannes Müller's doctrine of specific sensory energies to the fibres of the cochlear nerve: difference of tonal pitch is correlated with difference in the nerve fibre excited.[3] If, then, we follow the strict letter of the theory, we must suppose that the basilar fibres which vibrate on either side of the principal fibre, in any given case of tonal stimulation, move at the rate imposed on them by the stimulus, *i. e.*,

[1] *On the Sensations of Tone*, trs. by A. J. Ellis, 1895, 146 *b*.

[2] *Ibid.*, 144 *c*, 146 *c*, 147 *d*. The German word for 'sensible' is *merklich*. The context is physiological, and the term means 'large enough, physically, to be worth taking account of.'

[3] *Ibid.*, 148 *b*, *c*.

at the same rate as the principal fibre, but nevertheless mediate their own sensations. We have a strip or bundle of basilar fibres, all vibrating at their own frequencies — though with rapidly lessening intensity as we leave the centre of the strip, and all exciting the central organ in their own specific ways.[1]

There is a further point, dealt with by Helmholtz in an Appendix,[2] which becomes of importance later in our discussion. Theoretically, *i. e.*, if we make certain assumptions with regard to the structure of the basilar membrane and draw their mathematical consequences, "every excitement of a bundle of transverse fibres by the fundamental tone must be accompanied by weaker excitements of the unevenly numbered harmonic undertones." These undertone fibres excite their own nerve fibres, and should, accordingly, mediate their own sensations. "There is nothing of the kind observable in the ear." The reason is that "the appendages of the basilar membrane probably greatly impede the formation of tones with nodes."[3]

The physiological substrate of a simple tonal sensation is, therefore, threefold. We have (1) the strong sympathetic vibration of the basilar fibre whose proper tone lies nearest the tone of the stimulus. We have (2) the weaker sympathetic vibration of adjacent fibres. We have (3) the weak sympathetic vibration, with formation of nodes, of fibres carrying the odd-numbered harmonic undertones. The fibres of the two latter groups ought to arouse each their own proper tone. The undertone fibres, however, are so quickly damped that they are not represented in sensation. Helmholtz does not seem to have faced the difficulty that arises from the sympathetic vibration of the fibres adjoining the principal fibre,— the difficulty that these fibres must, in strictness, arouse their own tones, while only one single tone (the tone of the principal fibre) exists for sensation.

It may be said, at once, that this difficulty is not an insuperable objection to the Helmholtz theory. It may be overcome in various ways. Thus Stumpf, of whose views we shall have more to say presently, shows on physiological and psy-

[1] The easiest way to envisage the Helmholtz theory is to think of it as a one-to-one correlation of basilar fibre and specific nerve fibre. And there is nothing seriously misleading in such envisagement. It should, however, be remembered that Helmholtz himself speaks in terms, not of the basilar fibres, but of Corti's arches and Corti's fibres: see, *e. g.*, *ibid.*, 147 *b*, *c*. He nowhere commits himself to the statement that the number of basilar fibres is a measure of the number of possible tone sensations.

[2] *Ibid.*, 411 *b*, *c*.

[3] It appears (unfortunately we have not the earlier editions of the *Tonempfindungen* at hand) that these considerations were suggested to Helmholtz by Riemann's *Musikalische Logik*, 1877.

chological grounds that an accommodation of the specific energies of the nervous structures, within certain narrow limits of stimulation, is not only possible but even highly probable.[1]

Ebbinghaus' Modifications.

Ebbinghaus accepts, without reserve, the fundamental idea of the Helmholtz theory.[2] In order, however, to meet certain difficulties of application, he proposes two modifications. (1) The first is directed against an extreme interpretation of the doctrine of specific energies. The cells of the cochlear nerves, or their central representatives, are so constituted as to mediate tonal sensations under the influence of rhythmical stimuli. Originally, Ebbinghaus says, any cell can mediate any sensation. But since the cell is connected with the basilar fibre, only a certain limited number of rhythms are, as a matter of fact, conducted to it. The rhythm that affects it most easily is, of course, the proper rhythm of its own basilar fibre; so that, by a process of physiological adaptation (*Gewöhnung*), it comes to respond most quickly and most strongly to this particular form of stimulus. It can, however, also respond, within certain limits, to other rhythms.[3]

Suppose, then, that a simple tonal stimulus is given. It sets in vibration a strip of the basilar membrane, a group of adjacent basilar fibres. These fibres vibrate, one and all, in the rhythm of the incoming stimulus. The corresponding cells mediate, not each its own sensation, but all the same sensation, *i. e.*, the sensation directly correlated with the stimulus. They do this because they still retain something of their primitive indifference of function: they are not so specifically adapted that they cannot take up rhythmical impulses which vary, in some small degree, from the rhythm of their proper fibre. The cell that is most nearly attuned to the stimulus arouses the strongest excitation; the neighboring cells repeat the same excitation, only in weaker form.

(2) Helmholtz had remarked that the fibres carrying certain harmonic undertones must vibrate, with the formation of nodes, on the operation of a given tonal stimulus. He supposed these fibres to mediate their own sensations; and accounted for the fact that their tones are not heard by the weight of the structures attached to the basilar membrane.

---

[1] *Tonpsychologie*, ii, 1890, 111 ff., with other references there given. At the time that the *Tonpsychologie* was written, Stumpf was an adherent of the Helmholtz theory. He has now given it up: see, *e. g.*, *Beitr. z. Akustik u. Musikwiss*, i, 1898, 18 *note*, 51 f. This fact should be borne in mind in reading the later divisions of the present paper.

[2] *Psychologie*, i, 1897, 316.

[3] *Ibid.*, 318 ff.

Ebbinghaus questions the soundness of this explanation; strings are capable of strong vibration even when very heavily loaded. He himself believes that the undertone fibres vibrate, with the formation of nodes. But he differs from Helmholtz in supposing that not the odd-numbered only, but all the undertone fibres, down to a certain limit, are involved; and, further, that the partial vibrations as such constitute the stimulus to the relatively indifferent cells. The cell is primarily adapted to the rhythm of its proper fibre. It is secondarily adapted, as we have seen, to the rhythms of adjacent fibres. It is also secondarily adapted to rhythms that are twice, three times, four times, etc., as rapid as the rhythm of its proper fibre. The undertone fibres consequently mediate precisely the same sensation as do the fibres of the strip set in direct vibration by the stimulus.[1]

An illustration will make the matter clear. Suppose that a tone of 600 vs. in the 1 sec. is sounded outside the ear. The effect upon the cochlea is (*a*) that the 600-fibre and its cell are thrown into strong vibration. At the same time (*b*) the neighboring fibres and cells, above and below, are thrown into weaker vibration, and so mediate the same excitation in weaker form. Further, (*c*) the 300-fibre vibrates at twice its natural rate, the 200-fibre at three times its natural rate, and so on. The cell of the 300-fibre accepts, takes up, the 600-rhythm, and mediates (if we may use the expression) the 600-sensation. The cell of the 200-fibre also accepts the 600-rhythm, and mediates, less strongly, the same sensation. These long fibres mediate the sensation proper to the shorter 600-fibre by reason of the fact that their cells are fairly well accustomed to vibrations two, three, etc., times as rapid as those normal to the fibres upon which they sit.

We have nothing to object to these modifications. It must only be remembered that Ebbinghaus makes them under stress of the psychological facts, and that they are both entirely hypothetical. Helmholtz gives one conjectural interpretation of the function of the cochlea; Ebbinghaus gives another. If, now, it is a question of cutting a physiological theory to suit the needs of psychology, we shall incline to accept the theory, whosesoever it may be, that without doing violence to the established facts of physiology best takes account of the results of introspection. On the whole, Ebbinghaus' 'adaptation' seems to us to offer a better working hypothesis than Helmholtz' 'specific energy.' But both theories alike contain too much of guess-work and analogical reasoning to allow us to strike a decision between them. The test, for the psychologist,

[1] *Ibid.*, 320.

lies just in their power to explain. The test applied to Ebbinghaus' theory in the present paper is its explanation of the phenomena of beats.

THE PHENOMENA OF BEATS.

There can be no doubt that Helmholtz regarded beats, primarily, as *intensive* fluctuations of tonal sensation.[1] There can be no doubt, either, that he began his investigation with the slow beats formed when the two primary tones lie very near together upon the scale, and worked from these to the more rapid beats produced when the tones lie farther apart. Hence, beats appeared to him to be a very simple phenomenon, to be explained, as simply, by reference to the interference of vibrations. "Corti's arches,"[2] he says, "may be made to beat by two tones sufficiently near in pitch to set the same Corti's arches in sympathetic vibration at the same time. If, then, . . . the intensity of auditory sensation in the nerve fibres involved increases and decreases with the intensity of the elastic vibrations, the strength of the sensation must also increase and diminish in the same degree as the vibrations of the corresponding elastic appendages of the nerves."[3]

If we grant the introspective assumptions, this explanation is valid. Two neighboring tones are sounded. Each sets in vibration its own strip of the basilar membrane. These strips overlap; the same basilar fibres are affected by both stimuli, and there is interference. We therefore hear precisely what we should hear if there were no beats, except that the mass of sound is interrupted (or is subject to intensive fluctuation) at intervals corresponding to the difference in the vibration frequencies of the primary tones. The explanation is straightforward, and follows directly from the theory. The initial difficulty of the theory, the difficulty that a vibrating strip of the basilar membrane ought to give us a medley of different tonal sensations, of course remains.

Unfortunately, however, the facts as reported by introspection are less simple than Helmholtz supposed. We take Stumpf's account.

"(*a*) If I give two tones, about a semitone apart, in the middle region of the scale (*e. g.*, g^1-sharp and a^1 on the violin), I hear the two primary tones, but also, over and above these, a third tone which lies between them, somewhat nearer the lower than the higher. This third tone has a very soft coloring, and with keen attention is localized within the ear; it is this tone which beats, while the primary tones remain con-

---

[1] *Sensations of Tone*, 164 *c*, 165 *c*, *d*, 169 *a*. Stumpf, *Tonpsychologie*, ii, 450; *Beitr.*, 1, 4, *note*.

[2] Used in the sense explained *ibid.*, 147 *b*.

[3] *Ibid.*, 166 *c*, 167 *b*, *c*, 172 *a*, *b*.

stant. The two primary tones are, in my judgment, noticeably weakened, — more than is customary when two tones are sounded at the same time.

"(*b*) If I take tones that lie farther apart, in the same region of the scale (*e. g.*, g^1 and a^1), I do not hear any middle tone, but only the two primaries; and these two seem themselves to beat. If, however, I turn the attention more particularly to the one of them, this always appears to be the beating tone.

"(*c*) If, on the other hand, I take two tones that lie much nearer together than a musical semitone, so that they approximate the difference limen for simultaneous tones, I get one tone, and that beating. It is difficult to say whether it lies between the primaries."[1]

Stumpf's Explanations.

Stumpf seeks to account for these three observations in terms of the Helmholtz theory as modified by the hypothesis of physiological accommodation (accommodation of neighboring nerve fibres or their ganglion cells). If we grant Stumpf's presuppositions, the explanations are satisfactory. They are, in brief, as follows.

It is clear that Obs. (*c*)[2] is the typical observation required by the Helmholtz theory, and agrees with the observations made by Helmholtz himself. We need, therefore, spend no time upon it.

Obs. (*a*) demands more discussion. Stumpf supposes, with Helmholtz, that the two basilar strips, the g^1-sharp strip and the a^1 strip, partially overlap. We might, therefore, expect a priori to hear both the g^1-sharp and the a^1, and to hear both beating. What we actually hear is an intermediate beating tone, and the primaries sounding, smoothly but weakly, on either side. To explain the introspective phenomena, Stumpf appeals to his principle of nervous accommodation. There will be one intermediate nerve fibre, affected at equal strength by both forms of stimulation, for which the twofold "Erregungsweise am kräftigsten eintreten muss." It is then a simple extension of the principle of accommodation of nervous energies (*Bildung einer Gesammtenergie*) to assume that this intermediate nerve fibre or ganglion cell, giving its specific response under intensive stimulation, will constrain the neighboring fibres or cells in the direction of its own specific energy: so that the nervous structures excited fall, for purposes of sensation, into three groups, — an upper and a lower, replying specifically to the primary stimulations, and an intermediate, replying specifically to the intensive stimulation produced by

[1] Tonpsychologie, ii, 480 ff. [2] *Ibid.*, 488 f.

the joint operation of the two primary stimuli. In other words, we hear an intermediate tone, which carries the beats, and the two outlying tones, not beating, and weakened by the withdrawal (so to say) of certain of their constituent nerve fibres or nerve cells to the specific functional activity of the central zone.[1]

If we grant the presuppositions, this explanation is entirely acceptable. Stumpf gives further and very ingenious explanations of the peculiar coloring of the third tone, its localization, its pitch, and so on. We need not here enter into these details.

We come to Obs. (*b*). In this case, there is, according to Stumpf, a very slight overlapping of the basilar strips. The double excitation is thus too weak to arouse the intermediate nerve fibres or cells to their specific response. They beat; but they beat in the tone of the singly excited fibre or cell group above or below them. We therefore hear only the two primary tones, sounding more strongly than in Obs (*a*); and we hear them beating, for the reason that a certain portion of their physiological substrates is affected by both stimuli.[2] The shift of the beating tone with shift of attention is readily intelligible.

In fine, then, Stumpf is able to give, in terms of the Helmholtz theory and his own hypothesis of nervous accommodation, a coherent and adequate explanation of the three observations. His explanation of Obs (*a*) is especially happy. It is, in effect, a compromise—if one may speak of a compromise before both of the extremes have been formulated—between Helmholtz' doctrine of specific energies, and Ebbinghaus' doctrine of the original functional indifference of the cochlear cells.[3]

Ebbinghaus' Explanations.

Ebbinghaus accepts Stumpf's description of the phenomena. After describing Obs. (*b*) and (*c*), he proceeds to Obs. (*a*), as follows. "Nur bei geringer Höhendifferenz der Töne, etwa bis zu einem Halbton, verhält es sich, worauf Stumpf erst aufmerksam machte, etwas anders. Man hört dann einen *zwischenliegenden* Ton als Träger der Schwebungen, während die beiden objektiv erzeugten Töne entweder abgeschwächt und ruhigbleibend daneben hörbar sind oder auch—bei den geringsten Höhendifferenzen—ganz verschwinden. Eine Erklärung dieser *Zwischentöne* oder *resultierenden Töne* (Melde) wird später gegeben werden."[4]

Turning to the passage referred to, we read as follows:

---

[1] *Ibid.*, 484 ff.

[2] *Ibid.*, 487 f.

[3] Nevertheless, as will presently appear, we have a possible physical explanation of the *Zwischenton*, acceptance of which would render the accommodation hypothesis unnecessary.

[4] *Psychologie*, i, 1897, 304 f.

"Diese [Schwebungen] sollen [nach der Helmholtz'schen Theorie] dadurch zustande kommen, dass bei dem gleichzeitigen Erklingen zweier hinreichend benachbarter Töne die mitschwingenden Gebiete der Basilarmembran nicht mehr ganz getrennt bleiben, sondern teilweise übereinandergreifen, und die Bewegungen nun an den mittleren Fasern miteinander interferieren. Das passt vortrefflich, wenn die beiden objektiven Töne sehr nahe bei einander liegen. Dann hört man, wie oben mitgeteilt, in der That den nach der Theorie zu erwartenden *Zwischenton* als Träger der Schwebungen." [1]

Could anything be less satisfactory? The *Zwischenton* is precisely what the Helmholtz theory does *not* explain; it is precisely what we should *not* expect from that theory. What the Helmholtz theory would give us, in its strict form, is a medley of tones, some of which (the intermediate tones) are beating. What it under no circumstances can give us is the actual fact of observation,—two steady primaries and one beating intermediate tone.[2]

We may add that this Obs. is not either explained by Ebbinghaus' own modification of the Helmholtz theory. If the nervous appendages of the two basilar strips are 'adapted' to take up the two primary rhythms over their whole extent, there is no reason whatsoever to expect the appearance of an intermediate tone. This tone cannot, of course, be due to the sympathetic vibration of the undertone fibres, since these give the same sensation as the primary strips.[3]

As regards Obs. (*a*), therefore, Ebbinghaus leaves us just where we were left by Helmholtz. It is as if Stumpf had never written.

We pass to Obs. (*b*). "Aber es [the Helmholtz explanation] passt nicht mehr," Ebbinghaus goes on, "bei grösseren Entfernungen der primären Töne, etwa von einem Halbton ab.

---

[1] *Ibid.*, 317.

[2] Were it not for Helmholtz' specific energies, his theory might easily be so extended as to cover the intermediate tone of Obs. (*a*); for under certain conditions the superposition of two pendular vibrations of nearly the same frequency gives rise, theoretically, to a resultant vibration which lies midway between. See Rayleigh, *Theory of Sound*, 2 ed., i, 1894, 49,71; ii, 1896, 443, 450. In confirmation of these theoretical deductions, R. H. M. Bosanquet (*Phil. Mag.*, xi, 5 ser., 1881, 421) actually heard both the intermediate tone of Obs. (*a*) and the beating mass of Obs. (*c*) as lying midway between the primaries. Now Helmholtz' theory of analysis makes the beats of Obs. (*c*) mark the limit of Ohm's law; *i. e.*, beats arise when analysis is replaced by interference. The modification offered by the evidence just cited simply sets the limit of the law one degree higher, and brings not only the beating mass of (*c*) but also the intermediate tone of (*a*) under interference.

[3] Having broken away from H.'s specific energies, E. might well have explained the *Zwischenton* on the physical basis of the preceding note. But he rests on H.'s explanation, which is plainly inadequate.

Dann verschwindet der Zwischenton vollkommen, die Schwebungen aber, die noch an ihm haften sollen, verschwinden nicht auch sondern bleiben hörbar noch bei beträchtlich grösseren Intervallen, und zwar haften sie deutlich an den beiden primären Tönen. Als Träger der Schwebungen können mithin, wie die Sache auch oben bereits dargestellt wurde,[1] keine anderen Fasern der Basilarmembran in Betracht kommen als die den schwebenden Tönen direkt zugeordneten. Und nur wenn diese bis auf einen Halbton und weniger aneinander rücken, kommt es zu einem für die Empfindung merklich werdenden Uebereinandergreifen der beiden Erregungsgebiete."[2]

The vehicles of the beats are, in this case, not the intermediate overlapping fibres, but the fibres directly correlated with the stimulus rhythms. How do these fibres mediate beats? By virtue of their inelasticity. "Die mitschwingenden feinen Teilchen der Basilarmembran . . . haben doch zweifellos nur geringe elastische Kräfte, und können ihre Bewegung beim Aufhören des objektiven Anstosses aus sich heraus keine nennenswerte Zeit weiter fortsetzen. . . . Jene Amplitudenschwankungen der objektiven Tonwelle werden demnach von den sämmtlichen mit ihr schwingenden Gebieten der Basilarmembran leidlich getreu mitgemacht. Erfolgen sie relativ langsam, so hören wir sie als Schwebungen, bei grösserer Schnelligkeit als Rasseln, bei noch grösserer als Rauhigkeit."[3]

Now no one can deny that the basilar fibres may be as inelastic as Ebbinghaus supposes. But, if they are, their inelasticity should be taken into account for the other observations.[4] For inelasticity comes to the same thing as interference, since both mean a failure of analysis. If the analysis is incomplete in the larger intervals of (*b*), it must also be incomplete in the smaller intervals of (*a*), and the 'resting primaries' remain a mystery. In other words, E.'s appeal to inelasticity advances the limit of auditory analysis to the most remote separation of the primaries that gives rise to beats (*b*). The appeal must

---

[1] See p. 303.

[2] *Ibid.*, 317.

[3] *Ibid.*, 1902, 322; *cf.* 1897, 303. On p. 322 occurs the sentence: "Die mitschwingenden feinen Teilchen der Basilarmembran dürfen nun nicht etwa gedacht werden wie stimmgabelartige Gebilde, wie es seitens der Helmholtzschen Theorie eigentlich geschieht." How this can be said to 'eigentlich geschehen' on the part of the Helmholtz theory, in view of Helmholtz' own discussion of the damping of vibrations in the ear (*Sensations of Tone*, 142 *b* to 143 *d*), we fail to see.

[4] We have sought in vain, in Ebbinghaus' pages, for any definite qualification or limitation of this attribute of inelasticity. If it extends as far as beats extend, then we might surely look for fluctuations in the difference tones,—since they, like beats, depend upon an intensively fluctuating stimulus. *Cf.* also M. Meyer's remarks upon certain mistuned intervals. *Zeits.*, xvi, 1897, 15; Stumpf's *Beitr.*, ii, 1898, 39.

then *a fortiori* cover all lesser separations, and the smooth-sounding tones of (*a*) become anomalous.

Again, Ebbinghaus has, in terms of his own modification of the Helmholtz theory, an explanation of Obs. (*b*). The basilar strips directly correlated with the stimuli are so wide apart that there is no overlapping. But the undertone fibres are also vibrating; and the interval between these fibres gets steadily smaller and smaller, as the fibres themselves become longer. A point must be reached, before very long, at which the undertone strips will overlap, and at which there will consequently be beats due to Helmholtzian interference. There is, thus, no necessity for the appeal to inelasticity. The beats of Obs. (*b*) may be due to phenomena of interference among the undertone fibres. Ebbinghaus himself makes no mention of this possibility.

Our criticism of Ebbinghaus, then, amounts to this: that he has multiplied causes for Obs. (*b*), and has altogether failed to account for the intermediate tone and the resting primaries of Obs. (*a*). We do not say how far interference is due to inelasticity; we do not know. But if the fibres of the basilar membrane are inelastic, there is no place for the smoothly sounding tones of the latter Obs. —

Although the matter of beats is far from settled, the writers venture to suggest that the case is not altogether hopeless. In regard to the three introspective observations, they offer the following considerations. Obs. (*c*), the beating mass, is probably correlated with cochlear vibrations which repeat with more or less fidelity the resultant from two pendular vibration rates. Obs. (*a*) depends, in part, upon two analyzed components; and in part, upon an unanalyzed residue possessing an intermediate frequency. Obs (*b*) is, finally, to be referred to an almost complete analysis, in the sense of Ohm's law. The beating of the primaries may be explained by a small area of interference,—an area insufficient to mediate a distinct tone. The argument for Obs. (*b*) is supported by three bits of evidence. First, in Stumpf's introspections, it was difficult to localize the beat: the two primaries '*seem* themselves to beat;' but if either is attended to, that one '*always appears* to be the beating tone.' Secondly, weak and circumscribed interference might well give rise to intensive fluctuations without, however, producing a distinct tone (*cf.* weak partials discoverable only by beats). Thirdly, in our own experience, tones (*e. g.*, g^1 and a^1) which, when weak, are heard beating separately, give when excited more intensively a suggestion of an additional intermediate tone.

THE PROOF AND MEASUREMENT OF ASSOCIATION BETWEEN TWO THINGS.

By C. Spearman.

CONTENTS.

	Page
Introductory.	72
Part I. Elementary correlation, and "accidental deviations."	73
1. Requirements of a good method.	73
2. Standard methods explained.	77
3. Comparison by rank.	79
4. Auxiliary methods.	82
Part II. Correction of "systematic deviations."	88
1. Systematic deviations generally.	88
2. "Attenuation" by errors.	89
3. Limits of associative problems.	92
4. "Constriction" and "Dilation."	94
5. "Distortion."	95
6. Criticism of prevalent working methods.	96
7. Number of cases desirable for an experiment.	99

Introductory.

All knowledge—beyond that of bare isolated occurrence—deals with uniformities. Of the latter, some few have a claim to be considered absolute, such as mathematical implications and mechanical laws. But the vast majority are only *partial;* medicine does not teach that smallpox is inevitably escaped by vaccination, but that it is so generally; biology has not shown that all animals require organic food, but that nearly all do so; in daily life, a dark sky is no proof that it will rain, but merely a warning; even in morality, the sole categorical imperative alleged by Kant was the sinfulness of telling a lie, and few thinkers since have admitted so much as this to be valid universally. In psychology, more perhaps than in any other science, it is hard to find absolutely inflexible coincidences; occasionally, indeed, there appear uniformities sufficiently regular to be practically treated as laws, but infinitely the greater part of the observations hitherto recorded concern only more or less pronounced *tendencies* of one event or attribute to accompany another.

Under these circumstances, one might well have expected that the evidential evaluation and precise mensuration of tendencies had long been the subject of exhaustive investigation

and now formed one of the earliest sections in a beginner's psychological course. Instead, we find only a general naïve ignorance that there is anything about it requiring to be learnt. One after another, laborious series of experiments are executed and published with the purpose of demonstrating some connection between two events, wherein the otherwise learned psychologist reveals that his art of proving and measuring correspondence has not advanced beyond that of lay persons. The consequence has been that the significance of the experiments is not at all rightly understood, nor have any definite facts been elicited that may be either confirmed or refuted.

The present article is a commencement at attempting to remedy this deficiency of scientific correlation. With this view, it will be strictly confined to the needs of practical workers, and all theoretical mathematical demonstrations will be omitted; it may, however, be said that the relations stated have already received a large amount of empirical verification. Great thanks are due from me to Professor Haussdorff and to Dr. G. Lipps, each of whom have supplied a useful theorem in polynomial probability; the former has also very kindly given valuable advice concerning the proof of the important formulæ for elimination of "systematic deviations."

At the same time, and for the same reason, the meaning and working of the various formulæ have been explained sufficiently, it is hoped, to render them readily usable even by those whose knowledge of mathematics is elementary. The fundamental procedure is accompanied by simple imaginary examples, while the more advanced parts are illustrated by cases that have actually occurred in my personal experience. For more abundant and positive exemplification, the reader is requested to refer to the under cited research,[1] which is entirely built upon the principles and mathematical relations here laid down.

In conclusion, the general value of the methodics recommended is emphasized by a brief criticism of the best correlational work hitherto made public, and also the important question is discussed as to the number of "cases" required for an experimental series.

PART I.

ELEMENTARY CORRELATION AND "ACCIDENTAL DEVIATION."

1. Requirements of a Good Method of Correlation.

(a) Quantitative expression.

The most fundamental requisite is to be able to measure our observed correspondence by a plain numerical symbol. There

[1] 'General Intelligence,' determined and measured, to appear in a subsequent number of this *Journal*.

is no reason whatever to be satisfied either with vague generalities such as "large," "medium," "small," or, on the other hand, with complicated tables and compilations.

The first person to see the possibility of this immense advance seems to have been Galton, who, in 1886, writes: "the length of the arm is said to be correlated with that of the leg, because a person with a long arm has usually a long leg and conversely." [1] He then proceeds to devise the required symbol in such a way that it conveniently ranges from 1, for perfect correspondence, to 0 for entire independence, and on again to −1 for perfect correspondence inversely. By this means, correlations became comparable with other ones found either in different objects or by different observers; they were at last capable of leading to further conclusions, speculative and practical; in a word, they now assumed a scientific character.

Mathematically, it is clear that innumerable other systems of values are equally conceivable, similarly ranging from 1 to 0. One such, for instance, has been worked out and extensively used by myself (see pp. 86 ff). It therefore becomes necessary to discuss their relative merits.

(b) The significance of the quantity.

Galton's particular system is defined and most advantageously distinguished from all the others by the important property, that if any number of arms, for instance, be collected which are all any amount, $x\sigma_a$, above mean, then the corresponding legs will average $rx\sigma_l$ above the mean (with a middle or "quartile" deviation [2] of $\sigma_l \sqrt{1-r^2}$); where σ_a = the quartile variation of the arms, σ_l = that of the legs, and r is the measure of the correlation.

But another—theoretically far more valuable—property may conceivably attach to one among the possible systems of values expressing the correlation; this is, that a measure might be afforded of the *hidden underlying cause of the variations.* Suppose, for example, that A and B both derive their money from variable dividends and each gets $1/x^{th}$ of his total from some source common to both of them. Then evidently their respective incomes will have a certain tendency to rise and fall simultaneously; this correspondence will in any of the possible systems of values always be some function $1/x$, but in only one of them will it actually be itself $= 1/x$; in such a favored case, if A and B get, say, 20% of their respective incomes from the common source, the correlation between these two incomes will also show itself as 0.20; and conversely, if A's income happens to be found correlated with that of B by 0.20, then

[1] "Proceedings Royal Society of London." Vols. XL and XLV.
[2] Commonly, but misleadingly, termed the "probable error."

there is a likelihood that 0.20 of A's income coincides with 0.20 of B, leaving to either 0.80 disposable independently. The observed correlation thus becomes the direct expression of the relative amount of underlying influences tending for and against the correspondence.

In the above imagined instance, this desirable expressiveness belongs to the same above system of values proposed by Galton (and elaborated by Pearson). But this instance is exceptional and fundamentally different from the normal type. Evidently, A and B need not necessarily derive exactly the same proportion of their incomes from the common source; A might get his 0.20 while B got some totally different share; in which case, it will be found that the correlation is always the geometrical mean between the two shares. Let B be induced to put *all* his income into the common fund, then A need only put in $0.20^2 = 0.04$, to maintain the same correlation as before; since the geometrical mean between 0.04 and 1 is equal to 0.20.

Now, in psychological, as in most other actual correspondences, A and B are not to be regarded as in the fixed bisection of our first case, but rather as in the labile inter-accommodation of our second case. Hence A, in order to be correlated with B by $1/x$, must be considered to have only devoted $1/x^2$ (instead of $1/x$) of his arrangement to this purpose, and therefore to still have for further arrangements $1 - 1/x$,[2] which will enable an independent correlation to arise of $\sqrt{1 - 1/x^2}$. In short, not Galton's measure of correlation, but the *square thereof*, indicates the relative influence of the factors in A tending towards any observed correspondence as compared with the remaining components of A tending in other directions.

(c) Accuracy.

From this plurality of possible systems of values for the measure of the correlation must be carefully distinguished the variety of ways of calculating any one of them. These latter, again, have various advantages and disadvantages, of which the principal is their respective degrees of liability to "accidental deviation."

For, though the correlation between two series of data is an absolute mathematical fact, yet its whole real value lies in our being able to assume a likelihood of further cases taking a similar direction; we want to consider our results as a truly representative *sample*. Any one at all accustomed to original investigation must be aware how frequently phenomena will group themselves in such a manner as to convincingly suggest the existence of some law—when still more prolonged experiment reveals that the observed uniformity was due to pure hazard and has no tendency whatever to further repeat itself.

Luckily, this one great source of fallacy can be adequately

eliminated, owing to the fact that such accidental deviations are different in every individual case (hence are often called the "variable errors") and occur quite impartially in every direction according to the known laws of probability. The consequence is that they eventually more or less completely *compensate one another*, and thus finally present an approximately true result. Such elimination, however, must always remain theoretically incomplete, since no amount of chance coincidence is absolutely impossible; but beyond certain limits it becomes so extremely unlikely that for practical purposes we can afford to neglect it. When a person loses 14 times running at pitch-and-toss, he can reckon that such a series would not occur by mere accident once in 9,999 times, and consequently he will feel justified in attributing the coincidence to some constant disturbing influence. Similarly, to estimate the evidential value of any other observed uniformity, we only require to know how nearly the odds against chance coincidence have approached to some such standard maximum as 9,999 to 1. But, as any standard must always be more or less arbitrary—some thinking it too lenient and others unnecessarily severe—it is usual to employ a formula giving not the maximum but the middle deviation or "probable error."[1] We may then easily find the probability of mere hazard from the following comparative table:

If the observed correlation divided by the probable error be	—	1	2	3	4	5	6
then the frequency of occurrence by mere hazard	=	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{23}$	$\frac{1}{143}$	$\frac{1}{1250}$	$\frac{1}{19000}$

Now, the smallness of this probable error depends principally upon the number of cases observed, but also largely upon the mathematical method of correlation. Though a faultiness in the latter respect can theoretically be made good by increasing the range of the observations, yet such increase is not always possible, and, besides, has other grave disadvantages which will be discussed later on. Other things being equal, therefore, *the best method is that one which gives the least probable error.* For the benefit of the reader, this probable error should always be plainly stated; nothing more is required than a rough approximation; for while it is highly important to distinguish between a deduction worth, say, 0.9999 of perfect certainty and one worth only 0.75, it would be a mere splitting of straws to care whether a particular experiment works out to a validity of 0.84 or to one of 0.85.

(*d*) Ease of application.

[1] In the proper use of this expression.

The most accurate ways of calculation are generally somewhat difficult and slow to apply; often, too, there occur circumstances under which they cannot be used at all. Hence, in addition to a standard method, which must be used for finally establishing the principal results, there is urgent need, also, of *auxiliary methods* capable of being employed under the most varied conditions and with the utmost facility.

But here a word of warning appears not out of place. For such auxiliary methods are very numerous and their results, owing to accidents, will diverge to some extent from one another; so that the unwary, "self-suggested" experimenter may often be led unconsciously—but none the less unfairly—to pick out the one most favorable for his particular point, and thereby confer upon his work an unequivocality to which it is by no means entitled. Any departures from the recognized standard methods are only legitimate, either when absolutely necessary, or for mere preliminary work, or for indicating comparatively unimportant relations.

2. Standard Methods Explained.

(a) Correlations between variables that can be measured quantitatively.

This may be regarded as the normal type of correlation. Its standard method of calculation is that discovered by Bravais,[1] in 1846, and shown by Pearson, in 1896,[2] to be the best possible. Pearson terms this method that of "product moments."

The formula appears most conveniently expressed as follows:

$$r = \frac{Sxy}{\sqrt{Sx^2\, Sy^2}}$$

where x and y are the deviations of any pair of characteristics from their respective medians,

xy is the product of the above two values for any single individual,

Sxy is the sum of such products for all the individuals,

Sx^2 is the sum of the squares of all the various values of x,

Sy^2 is similarly for y,

and r is the required correlation.

A simple example may make this method clearer. Suppose that it was desired to correlate acuteness of sight with that of hearing, and that for this purpose five persons were tested as to the greatest distance at which they could read and hear a standard alphabet and sound respectively. Suppose the results to be :

---

[1] "Memoires par divers savants," T. IX, Paris, pp 255-332.

[2] "Phil. Trans., R. S., London," Vol. CLXXXVII, A, p. 164.

Person	Sight	Hearing
A	6 ft.	6 ft.
B	7	11
C	9 (median)	12
D	11	10 (median)
E	14	8

then, we get

	x	y	xy	x^2	y^2
A	− 3	− 4	+ 12	9	16
B	− 2	+ 1	− 2	4	1
C	0	+ 2	0	0	4
D	+ 2	0	0	4	0
E	+ 5	− 2	− 10	25	4

$$Sxy = \begin{cases} +12 \\ -12 \end{cases} \quad Sx^2 = 42 \quad Sy^2 = 25$$

so that $r = \dfrac{+12 - 12}{\sqrt{42 \times 25}} = 0$, and there, thus, is no correspondence, direct or inverse.

The "probable error" between any obtained correlation and the really existing correspondence has been determined by Pearson, as being "with sufficient accuracy" when a fairly large number of cases have been taken,

$$= 0.674506 \quad \frac{1 - r^2}{\sqrt{n\ (1 + r^2)}}$$

For discussion of correlation between characteristics whose distribution differs considerably from the normal probability curve as regards either "range" or "skewness," reference may be made to the works below.[1] It may be remarked that the method of "product moments" is valid, whether or not the distribution follow the normal law of frequency, so long as the "regression" is linear.

(b) Correlation between characteristics that can *not* be measured quantitatively.

In the example quoted by Galton, of correspondence between the length of arm and that of leg, it may be noted that the correspondence is proportional quantitatively; a long arm has a tendency to be accompanied by a leg not only long, but long to the same degree. Now, in many cases, such proportionality is by the nature of things excluded; a printed word is possibly remembered better than one heard; but, nevertheless, we cannot, in accordance with the preceding formula, ascertain whether degrees of visuality are correlated to retentiveness of memory, seeing that in the former case there do not exist any degrees, a word being simply either seen or not seen. Perhaps even

---

[1] Udny Yule: "Proc. R. S. London," Vol. LX, p. 477.
Pearson: "Phil. Trans. R. S. London," Vol. CLXXXV, I A, p. 71; Vol. CLXXXVI, I A, p. 343, and Vol. CXCI A, p. 229.
G. Lipps: "Die Theorie der Collectivgegenstände," Wundt's Phil. Stud., Vol. XVII.

more numerous are those cases where proportionality does indeed exist, but practically will not admit of being measured; for instance, it is probable that conscientiousness is to some extent a hereditary quality, yet we cannot well directly determine whether brothers tend to possess precisely the same amount of it, owing to the fact that we cannot exactly measure it.

In all such cases we must confine ourselves to counting the frequencies of coexistence. We can easily find out how often seen and spoken words are respectively remembered and forgotten. It has proved quite feasible to divide the children of a school generally into "conscientious" and "non-conscientious," and then to measure how much brothers tend to be in the same division; when we have proved this simple association, we may provisionally assume correlation of quantity also; that is to say, if the "conscientious," generally speaking, have a particular degree of tendency to possess brothers likewise "conscientious," then boys with excessively tender scruples will have the same degree of tendency to possess brothers with similarly excessive tenderness, while those with only a moderate amount of virtue will be thus correlated with brothers also of only moderate virtue; further, the ethical resemblance may be expected to repeat itself in cousins, etc., only reduced in proportion as the kinship is diminished.

For measurement of this non-proportional association, a standard method, which may be termed that of "cross multiples," has been elaborated by Sheppard,[1] Bramley-Moore, Filon, Lee, and Pearson. The formula is, unfortunately, too long and complicated to be usefully quoted in this place. It will be found in the under cited work,[2] together with its probable error as determined by Pearson.[3] In practice, it will generally have to be replaced by one of the more convenient methods to be next described.

3. **Comparison by Rank.**

This method of "cross multiples" is not only difficult and tedious of application, but also it gives a probable error nearly double that of "product moments."

Now, it can often be altogether escaped in the case of quantities not admitting absolute measurement, by substituting instead *comparison*. This other way will be discussed at some length, as it has been largely used by myself and is believed chiefly responsible for some successful experiments. All characteristics may be collated from two quite distinct aspects: either (as in example of visual and auditory acuteness) by actual

[1] "Phil. Trans.," Vol. CXCII, A, p. 141.
[2] "Phil. Trans.," Vol. CXCV A, pp. 2-7.
[3] "Phil. Trans.," Vol. CXCV A, 10-14.

mensuration, or else by order of merit; we might say that a student, A, obtained 8,000 marks in an examination, while B only got 6,000; or, instead, we might say that A was third out of 100 candidates, while B was only 20th. Precisely the same method of calculation may be again used in the latter case, simply substituting the inverse ranks, 97, 80, etc., for the performances, 8,000, 6,000, etc.

(a) Disadvantages of the "Rank" method.

In the first place, it may be objected that the observed correlation would then only hold good for persons of the same average difference from one another. For assuming, say, acute sight to be correlated with acute hearing; then the order of merit of A, B and C, as regards sight, is more likely to remain unaltered as regards hearing also, when the difference in their respective powers of vision is extremely marked, than when they are practically equal on the latter head. But the more numerous the persons experimented on, the less will be the average difference of faculty; it might, therefore, be supposed that the correlation would become continually less perfect as the experiments were made more extensive. This, however, would be a fallacy: 100 experimental subjects compared together by "Rank" would on the whole actually show appreciably the same average correlation as 1,000, provided, that in either case the subjects are selected by chance; the amount of the correlation is not really dependent upon the difference between the grades, but upon the relation of this difference to the mean deviation; and both of these increase together with the number of subjects. On the other hand, the correlation will undoubtedly diminish if the subjects be all chosen from a more homogeneous class; in a select training school for teachers, for example, general intelligence will throughout show smaller correlation with other qualities, than would be the case in a college for quite average young men of the same age; but this fact applies just as much to comparison by "Measurement."

The next possible objection is that comparison by rank bases itself upon an assumption that all the subjects differ from one another by the same amount, whereas A may differ from B five times as much as B differs from C. But such an assumption would only take place, if correspondence by rank were considered to be wholly equivalent to that by measurement; no such assumption is made; the two aspects are recognized to be theoretically distinct, but advantage is taken of the fact that they give correlational values sensibly equivalent in amount. Even against the small existing discrepancy may be set off a deviation of the same order of magnitude which is incurred when using measurement itself, owing to the practical necessity of throwing the cases into a number of groups.

The third and only solid objection is that rank affords a theoretically somewhat less full criterion of correspondence than does measurement; and the force, even of this argument, disappears on considering that the two methods give appreciably the same correlational values.

(b) Advantages of the "Rank" method.

The chief of these is the large reduction of the "accidental error." In a normal frequency curve, the outlying exceptional cases are much more spaced apart than are those nearer to the average; hence, any accident disturbing the position of these exceptional cases will have unduly great effect on the general result of the correlation; and owing to this inequality in the influence of the errors, the latter will not compensate one another with the same readiness as usual. Moreover, it is just these hyper-influential extreme cases where there is most likelihood of accidental errors and where there very frequently prevails a law quite different from that governing the great bulk of the cases. As regards the quantity of this gain by using rank (abstracting from the last mentioned point, which cannot well be estimated in any general manner) there should be no difficulty in calculating it mathematically. From a considerable amount of empirical evidence, the probable error when using the method of "product moments" with rank appears to become less than two-thirds of that given by the same method with measurement, and therefore only about one-third of that given by the method of "cross multiples."

The next advantage is that rank eliminates any disparity between the two characteristics compared, as regards their general system of distribution; such a disparity is often not intrinsic or in any way relevant, but merely an effect of the particular manner of gaining the measurement. By means of rank, a series presenting the normal frequency curve can be compared on even terms with another series whose curve is entirely different. This cannot well be done when using measurement. (See p. 78.)

Rank has also the useful property of allowing any two series to be easily and fairly combined into a third composite one.

(c) Conclusion.

From the practical point of view, it is so urgently desirable to obtain the smallest probable error with a given number of subjects, that the method of rank must often have the preference even when we are dealing with two series of measurements properly comparable with one another.

Theoretically, rank is at any rate preferable to such a hybrid and unmeaning correlation as that between essential measurements on the one side and mere arbitrary classification on the other. As the latter occur in most psychological correlations,

the only other resource would be to avoid measurements altogether by using the method of "cross multiples." But this trebles the size of the probable error, and therefore renders it necessary that the subjects should be no less than nine times as numerous; such an enormous increase, even if possible, would generally be accompanied by disadvantages infinitely outweighing the supposed theoretical superiority of method.

The above advantages are still further enhanced whenever dealing with *one-sided* frequency curves, such as are furnished by most mental tests. For in these cases the great bulk of influence upon the resulting correlation is derived exclusively from the very worst performances and is consequently of a specially doubtful validity.

In short, correlation by rank, in most cases a desirable procedure, is for short series quite indispensable, rendering them of equal evidential value to much longer ones treated by other ways. Luckily, it is precisely in short series that gradation by rank is practically attainable.

4. Auxiliary Methods.

These, as has been said, are only for use when there is adequate reason for not employing the above "standard" methods. Any number are devisable. Their resulting correlational values do not quite coincide with those found by the standard ways, but nearly enough so for most practical purposes.

(a) Auxiliary methods of Pearson.

Several very ingenious and convenient ones are furnished by him,[1] but all of similar type and requiring the same data as that of "cross-multiples."[2] They are therefore for use when the compared events do not admit of direct quantitative correlation. The following appears to combine facility and precision to the greatest degree:

$$r = \sin \frac{\pi}{2} \frac{\sqrt{ad} - \sqrt{bc}}{\sqrt{ad} + \sqrt{bc}}$$

where the two compared series of characteristics, say P and Q are each divided into two (preferably about equal) classes; if the case is one where quantity exists but cannot be absolutely measured, P II will comprise the instances in which P is in manifest deficiency; but if the compared characteristics essentially exclude quantity, P II become the instances where P is

---

[1] "Phil. Trans. R. S. L.," Vol. CXCV, A, pp. 1 and 79.

[2] They are all refinements of the original formula, $r = \frac{ad - bc}{ad + bc}$, published by Yule, Proc. R. S. L.," Vol. LXVI, p. 23.

absent; similarly Q. Then,

a =	the number	of times	that	P I	is accompanied	by	Q I
b	"	"	"	"	"	P II	"	"	Q I
c	"	"	"	"	"	P I	"	"	Q II
d	"	"	"	"	"	P II	"	"	Q II.

If $a + b$ is not very unequal to $c + d$, the probable error may be taken at about $1.1/\sqrt{n}$, where $n =$ the number of instances in the whole of P or of Q.[1]

Returning to our previous illustration, suppose that it was desired positively to ascertain the merits of instruction by writing and by word of mouth respectively. Ten series, each consisting of ten printed words, have been successively shown to a class of twenty children, who each time had to write down by memory as many as they could. The experiment was next repeated, but reading the words aloud instead of showing them. Of the 2,000 visual impressions 900 were correctly remembered, while of the same number of auditory ones only 700 were retained.

Call the visual	impressions	P I
" " auditory	"	P II
" " remembered	"	Q I
" " forgotten	"	Q II

then $a = 900$, $b = 700$, $c = 1{,}100$, $d = 1{,}300$, and

$$r = \sin \frac{\pi}{2} \frac{\sqrt{900} \times \sqrt{1{,}300} - \sqrt{700} \times \sqrt{1{,}100}}{\sqrt{900} \quad \sqrt{1{,}300} + \sqrt{700} \quad \sqrt{1{,}100}} = 0.16$$

The probable error then comes to $1.1/\sqrt{4{,}000} =$ nearly 0.02, or about 1/8 of the above correlation; so that the latter would not occur by mere chance once in 100,000 times.

We thus see that there is at any rate good *prima facie* evidence of some superiority on the part of the visual sense. Also, if the experiment has been fairly executed and adequately described, any subseqent verification under sufficiently similar conditions, by other experimenters, should result in a concordant correlation, probably between 0.14 and 0.18, and certainly between 0.04 and 0.28.

Moreover, we have obtained a direct estimate of the importance of this apparent superiority of the visual sense; for the square of the correlation amounts to 0.025; so that of the various causes here tending to make the children remember some words better than others, the difference of sense impressed comes to about one fortieth part (see p. 75).

[1] More accurately, $\sin 0.1686\,\pi\,(1 - r^2)\sqrt{\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}}$

(b) Method of proportional changes.

This is very often convenient, being especially applicable to a large number of psychological experiments, and so easy that the result can be approximately seen on inspection. Here,

$$r = \frac{3\ a - b^1}{2\ a + b}$$

where a = the number of cases that have changed in accordance with the supposed correspondence, and b = the number that have changed in contradiction of it. The probable error again comes to $\frac{1.1}{\sqrt{n}}$.

Suppose, for example, we were demonstrating that intellectual fatigue may be satisfactorily investigated by the method of Griessbach.[2] With this view, we have applied his test to 100 boys before and after their lessons. In the latter case 68 of them have presented the expected duller sensitivity, but 32, on the contrary, have shown a finer discrimination than before work.

Now, clearly, had the correspondence been perfect, *all* the hundred would have become worse.[3] Thus,

$$r = \frac{3}{2} \quad \frac{68 - 32}{100} \quad = 0.54.$$

As the probable error comes to 0.11, our imaginary correlation is five times greater, and therefore would not have occurred by mere accident more than once in 1,250 times; so that we become practically certain that the sensitivity of the skin really does measure fatigue.

It now becomes easy to compare the quantity of this fatigue at different stages of work. Let us say that further experiments, after lessons lasting one hour longer than before, showed the correlation had risen to 0.77. Thereby we see that the influence of fatigue swells from 0.54^2 to 0.77^2, that is, from being 1/5 to being 3/5 of all the sources of variation in cutaneous sensitivity. Such a result has a very different scientific significance from, say, any conclusion that the average sensory threshold had enlarged by so many more millimetres.

---

[1] Hence, when the correlation is very complete, say, over 0.75, the above formula gives appreciably too large values; as the amount reaches 0.90 and 1, the first factor must be reduced from 3/2 to 5/4 and 1 respectively.

[2] This, as is well known, consists in determining the least distance apart at which two points of contact can be distinguished as being double and not single.

[3] Assuming, that is to say, that all the boys become fatigued by the lessons.

Moreover, our test can be *easily and precisely compared with any of the various other recommended procedures*, being more reliable than all which present smaller correlations and *vice versa*.

(c) Method of class averages.

It often happens that measurements (or ranks) are known, but not in such a way as to be able to use either the method of "product moments" or even any of the methods of Pearson. Under such circumstances, I have found it very useful to be able to apply the following relation:

$$r = \frac{d}{D}$$

More accurately, $r = \sin\frac{\pi}{2} \cdot \frac{a - b}{a + b}$

where d is the observed difference between the average measurement (or rank) of the P's accompanied by Q I and that of those accompanied by Q II, and D is the greatest difference that was possible (such as would have occurred, had the correspondence been perfect). If Q has been divided into two about equal portions, D will be equal to twice the middle or "quartile" deviation from the average in the whole series P; while if Q has been divided after the usual fashion into three such portions, only the two outer ones can be used and then D = 2.87 times the above middle deviation (again taken in the whole series P).

Suppose, for example, that we wish to ascertain whether the well known test of "reaction-time" gives any indication as to the person's general speed of movement. We try a hundred persons both in reaction-time and in speed of running 50 yards. Then we divide the reaction-time records into two classes, I containing all the quickest performers and II all the slowest. We now see how long these two classes of reacters took respectively to run the fifty yards, and what was the middle deviation from the average among all the runners taken together. Let us put the average of class I at 6 seconds, that of class II at 6.5 seconds, and the general middle deviation at 1.1 seconds. Then

$$r = \frac{6.5 - 6}{2 \times 1.1} = 0.23$$

The evidential value of the result is given approximately, even for small values of n, by the following relation:

$$\text{probable error} = \frac{1.17}{\sqrt{n}} \cdot \frac{\sqrt{n} + 1}{\sqrt{n} + 2}$$

where n is the *total* number of cases considered. In the three-

fold instead of twofold division, the probable error becomes nearly

$$\frac{1.4}{\sqrt{n}}\ \frac{\sqrt{n+1}}{\sqrt{n+2}}$$

In the above instance, we find that the observed correlation is little over double the probable error; as so much would turn up about once in six times by mere accident, the evidence is not at all conclusive. Therefore we must either observe many more cases — 600 would be necessary to reduce the probable error to 1/5th of the correlation — or else we must find a better method of calculation. If rank had been employed instead of measurement, the evidence would already have been fairly good, and could have been put beyond all reproach by the addition of another 150 observations. If rank had been employed in conjunction with the method of "product moments" or that of "rank differences," the required smallness of probable error could have been obtained by as few as 36 cases in all!

The method of "class averages" is especially valuable in deciphering the results of other investigators, where the average performances and the middle deviation are usually given (in good work), but not the data required for any of the other methods.

(d) Method of rank differences.

This method appears to deserve mention also, seeing that it seems to unite the facility of the auxiliary methods with a maximum accuracy like that given by "product moments." It depends upon noting how much each individual's rank in the one faculty differs from his rank in the other one; evidently, this will be nil when the correlation is perfect, and will increase as the correlation diminishes.[1]

---

[1] This general idea seems to have been first due to Binet and Henri ("La fatigue intellectuelle," p. 252-261), who, however, do not work it out far enough to obtain any definite measure of correlation. Accordingly, Binet makes little further attempt in later research (L'année psychologique, Vol. IV) to render it of service, and soon appears to have altogether dropped it (L'année psychologique, Vol. VI).

The same idea occurred to myself and was developed as above, without being at the time acquainted with the previous work in this direction by Binet and Henri. In obtaining the above formulæ I was greatly assisted by Dr. G. Lipps' showing generally that when an urn contains n balls numbered 1, 2, 3, . . . , n, respectively; and when they are all drawn in turn (without being replaced); and when the difference is each time noted between the number on the ball and the order of its drawing; then the most probable (or middle) total sum of such differences, added together without regard to sign, will be $= \frac{n^2 - 1}{3}$. Previously, I had only calculated this value for each particular size of n required by myself. Prof Hausdorff further showed, generally, that such sum of differences will present a mean square deviation (from the above most probable value) $= \sqrt{\frac{(n+1)(2n^2+7)}{45}}$

The relation is as follows:

$$R = 1 - \frac{3Sd}{n^2 - 1}$$ [1]

where Sd is the sum of the differences of rank for all the individuals,

n is the total number of individuals,

and R is the required correlation.

The probable error will then be approximately, even for small values of n, $= 0.4/\sqrt{n}$.

To take again the example from p. 80, we number the five persons according to their order of merit in hearing and seeing respectively.

PERSON.	SEEING RANK.	HEARING RANK.	DIFFERENCE.
A	1	1	0
B	2	4	2
C	3	5	2
D	4	3	1
E	5	2	3
		Sd =	8

so that

$$R = 1 - \frac{3 \times 8}{25 - 1} = 0,$$

and again we find that there is no correlation, direct or inverse.

This method, though very accurate and pre-eminently quick in application, has unfortunately four serious disadvantages.

It can be only used for ranks, and not immediately for measurements.

The probable error given is only that showing how great correlations may be expected from pure accident when there is no really existing correspondence between the two characteristics. It does not (like Pearson's probable error for the method of "product moments") directly show how much the observed correlation may be expected to differ by accident from any correspondence that does exist.

The various possible values of Sd are found to fall into a frequency curve of marked asymmetry; so that we cannot (as in all the other methods here given) take the *minus* values of R as representing so much *inverse* correlation. This defect could be remedied mathematically; but there are also other respects in which this side of the frequency curve appears unsuitable for our purpose, so that it is better to treat every cor-

[1] This formula becomes slightly incorrect, whenever two or more individuals are bracketed as having precisely the same rank; but the consequent error is usually too small to be worth considering.

relation as positive (which can always be done by, if necessary, inverting the order of one of the series).

Finally, this value R is not numerically equivalent to the "r" found by all the other methods, but for chance distributions appears $= \sqrt{r^2}$. So far, the proof of this relation is only empirical, but it rests on a large number of cases taken, however, only between 0.20 and 0.60. If it be accepted r can at once be found from the following table:

R	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1
r	0.13	0.22	0.34	0.44	0.54	0.63	0.71	0.79	0.86	0.93	1

PART II.

Correction of "Systematic Deviations."

1. Systematic Deviations Generally.

In the first part, we have seen that any correlational experiments, however extensive, can only be regarded as a "sample" out of the immense reality, and will consequently present a certain amount of accidental deviation from the real general tendency; we have further seen that this accidental deviation is measurable by the "probable error," whose determination, therefore, becomes an indispensable requisite to all serious research.

But now we are in danger of falling from Scylla into Charybdis. For after laboriously compiling sufficient cases and conscientiously determining the probable error, there exists a very human tendency to cease from labor and inwardly rejoice at having thus risen from common fallacious argument to the serene certainty of mathematics. But whether or not such complacency may be justifiable in pure statistical inquiry, it is at any rate altogether premature in the kind of research that we are at present contemplating; we are not dealing with statistics, but with a line of work so fundamentally different, that it may be aptly distinguished by the term of "statisticoids." Here the accidental deviation is not the sole one, nor even the most momentous; there are many other enemies who are unmoved by the most formidable array of figures. These consist in such deviations as, instead of merely being balanced imperfectly, lie wholly on the one side or the other. As in ordinary measurements, so too in correlation, we may speak, not only of "accidental," "variable," or "compensating" inaccuracies, but also of "systematic," "constant," or "non-compensating" ones.

These systematic deviations are of very varied nature, the most insidious being, as usual, *self-suggestion*. To take, for instance, one of our recent examples, suppose that we have applied the Griessbach test to a number of children before and

after their lessons, and have found the desired correlation between fatigue and cutaneous insensitivity, it still remains exceedingly difficult to convince ourselves that we executed our tests entirely without favor or affection; for it is almost impossible to determine a series of sensory thresholds without some general tendency, either to bring them towards the desired shape, or else—endeavoring to escape such bias—to force them in the opposite direction. To convince others of our impartiality may be harder still. Even this sort of deviation is to be remedied by our proposed exact method of procedure, for by it we obtain perfectly definite results which any impartial experimenters may positively corroborate or refute.

2. "Attenuation" by Errors.

From page 74 it will be obvious that a correlation does not simply depend on the amount of concording factors in the two compared series, but solely on the proportion between these concording elements on the one hand and the discording ones on the other. In our example, it did not matter whether A and B each had one pound or a thousand pounds in the common funds, but only whether the amount was a small or large fraction of their whole incomes. If the discordance, $1 - x$, be nil, then the concordance, x, is thereby perfect, that is, $= 1$; and if the influence of the discordant elements be sufficiently increased, then any concordance will eventually become infinitely small.

To consider a still more concrete example, suppose three balls to be rolled along a well-kept lawn; then the various distances they go will be almost perfectly correlated to the various forces with which they were impelled. But let these balls be cast with the same inequalities of force down a rough mountain side; then the respective distances eventually attained will have but faint correspondence to the respective original momenta.[1]

Thus it will be clear that here the accidental deviations have a new consequence simultaneous with, but quite distinct from, that discussed in the last chapter. For there, they impartially augmented and diminished the correlation, tending in a prolonged series to always more and more perfectly counterbalance one another; and in ordinary measurements, this is their sole result. But here in correlations, they also have this new effect which is always in the direction of "attenuating" the apparent correspondence and whose amount, depending solely on the size of the middle error, cannot be in the least eliminated by

[1] This fact has already been mathematically expressed in the last chapter by the value of correlation between two series being proportional (inversely) to the value of the middle deviations inside the series (see p. 86).

any prolongation of the series. The deviation has thus become general or "systematic."

Now, suppose that we wish to ascertain the correspondence between a series of values, p, and another series, q. By practical observation we evidently do not obtain the true objective values, p and q, but only approximations which we will call p' and q'. Obviously, p' is less closely connected with q', than is p with q, for the first pair only correspond at all by the intermediation of the second pair; the real correspondence between p and q, shortly r_{pq}, has been "attenuated" into $r_{p'q'}$.

To ascertain the amount of this attenuation, and thereby discover the true correlation, it appears *necessary to make two or more independent series of observations of both p and q.* Then,

$$r_{pq} = \frac{r_{p'q'}}{\sqrt{r_{p'p'} \cdot r_{q'q'}}}$$

where $r_{p'q'}$ = the mean of the correlations between each series of values obtained for p with each series obtained for q.

$r_{p'p'}$ = the average correlation between one and another of these several independently obtained series of values for p.

$r_{q'q'}$ = the same as regards q.

and r_{pq} = the required real correlation between the true objective values of p and q.

Thus, if for each characteristic two such independent series of observations be made, say p_1 p_2 q_1 and q_2, then the true

$$r_{pq} = \frac{r_{p_1q_1} + r_{p_1q_2} + r_{p_2q_1} + r_{p_2q_2}}{4\sqrt{(r_{p_1p_2} \times r_{q_1q_2})}}$$

Should circumstances happen to render, say, p_1, much more accurate than p_2, then the correlations involving p_1 will be considerably greater than those involving p_2. In such case, the numerator of the above fraction must be formed by the geometrical instead of by the arithmetical mean; hereby the accidental errors of the respective observations cease to eliminate one another and therefore double their final influence; they also introduce an undue diminution of the fraction.[1]

In some exceptional and principally very theoretical cases, it may happen that either of the actual measurements, say p'_1 is

[1] By an inversion of the above formula, the correlation between two series of observations will be found a useful measure of the accuracy of the observations.

connected with q′ (or q) quite independently of p or any other link common to p'_2. Then, the correlation $r_{p'q'}$ will be to that extent increased without any proportional increase in $r_{p'p'}$; hence our above formula will fallaciously present too large a value.

A greater practical difficulty is that of obtaining two series sufficiently independent of one another. For many errors are likely to repeat themselves; even two separate observers are generally, to some extent, warped by the same influences; we are all imposed on by, not only the "Idola Specus," but also the "Idola Tribus" and the "Idola Fori." In such case, the above formula is still valid, only its correction does not go quite far enough,—a fallacy at any rate on the right side.

An actual instance will best show the urgent necessity of correcting this attenuation. In a correlation between two events, say P and Q, I obtained three independent observations both of P and of Q. The average correlation for those of P with those for Q was 0.38 ($= r_{p'q'}$); the average correlation of those for P with one another was 0.58 ($= r_{p'p'}$); the same for Q was 0.22 ($= r_{q'q'}$). Therefore, the correspondence between the real events, P and Q, comes by reckoning to $\frac{0.38}{\sqrt{0.58 \times 0.22}}$ = approximately 1; so that the correspondence, instead of being merely 0.38, appeared to be absolute and complete.

Attenuation by errors can also be corrected in another manner, which has the great advantage of an independent empirical basis, and therefore of not being subject to either of the two above mentioned fallacies besetting the other method. Hence, when the results coincide both ways, the fallacies in question may thereby be considered as disproved, for it is very unlikely that they should both be present and in such proportions as to exactly cancel one another. In this method, instead of directly employing the values p_1 p_2 p_3, etc., we amalgamate them into a single list; by this means we clearly eliminate *some portion* of the individual observational errors, and thereby we cause any really existing correspondence to reveal itself in greater completeness. Now, this increase in correlation from this partial elimination of errors will furnish a measure of the increase to be expected from an *entire* elimination of errors. Assuming the mean error to be inversely proportional both to this increase in the correlation and to the square root of the number of lists amalgamated, the relation will be:

$$r_{pq} = \frac{\sqrt{mn}.r_{p''q''} - r_{p'q'}}{\sqrt{mn} - 1}$$

where m and n = the number of independent gradings for p and q respectively,

$r_{p'q'}$ = the mean correlation between the various gradings for p and those for q,

and $r_{p''q''}$ = the correlation of the amalgamated series for p with the amalgamated series for q.

In the above quoted instance, the three observations for series P were amalgamated into a single list, and similarly those for series Q. Upon this being done, the two amalgamated lists now presented a correlation with one another of no less than 0.66 ($= r_{p''q''}$). Thus by this mode of reckoning, the real correspondence became

$$= \frac{\sqrt[4]{3 \times 3 \times 0.66} - 0.38}{\sqrt[4]{3 \times 3 - 1}} = \text{once more approximately } 1,$$

so that this way also the correspondence advanced from 0.38 to absolute completeness.

If more than two independent series of observations are available, we may acquire additional evidence by trying the effect of *partial* amalgamation. Instead of throwing all our obtained values together, we may form a set of smaller combinations for each of the two compared characteristics, and then see the mean correlation between one set and the other. In our above instance instead of summarily considering $p'_1\ p'_2\ p'_3$, we can have $p'_1\ p'_2$, $p'_1\ p'_3$, and $p'_2\ p'_3$, and find out their mean correlation with similar values for q. This works out actually to 0.55. Hence

$$r_{pq} = \frac{\sqrt[4]{2 \times 2 \times 0.55} - 0.38}{\sqrt[4]{2 \times 2 - 1}} = \text{approximately } 1.$$

Thus, again, by this third way, where both terms are the mean of 9 observed correlational values, the correspondence once more rises from the apparent 0.38 to the real 1.[1]

3. Limits of Associative Problems.

We have seen that "the length of the arm is said to be correlated with that of the leg, because a person with a long arm has usually a long leg and conversely;" also that this correlation is defined mathematically by any constant which deter-

[1] The exactness of the coincidence between the two methods of correction is in the above instance neither greater nor less than generally occurs in practice. It was singled out, in order to show that the formulæ still hold perfectly good even for such an enormous rise as from 0.38 to 1. The possibility of such a rise is due to the unusual conditions of the experiment in question, whereby the three observations of the same objective series presented the extraordinarily small inter-correlation of 0.22.

mines the function of any definite size of arm to the mean of the sizes of the corresponding legs. These terms, taken literally, are very wide reaching and express what we will call the "universal" correlation between the two organs.

But evidently not the most painstaking investigation can possibly secure any adequately representative sample for such universal correlations, even in the simple case of arms and legs. To begin with, they would have to be equally derived from every stage of growth, including all the prenatal period; since this is the most influential of all causes of variation in size. In the next place, they would have to come from every historical epoch, containing their fair proportion of big Cro-Magnons, little Furfoozers, etc. Further, they must impartially include every living race, from the great Patagonians to the diminutive M'Kabbas; also every social class, from the tall aristocrats to the under-sized slummers.

Practically, then, the universal correlation, even if desirable, is quite inaccessible. We are forced to successively introduce a large number of restrictions: the sample is confined to adults, to moderns, to some particular country, etc., etc. In a word, we are obliged to deal with a *special* correlation.

When we proceed to more narrowly consider these restrictions, it soon becomes clear that they are far from being really detrimental. For every serious investigation will be found to be directed, however vaguely and unconsciously, by some hypothesis as to the causes both of the correspondence and of the digression therefrom (see page 74). This hypothesis will determine a particular system of restrictions, such as to set the correspondence in the most significant relief.

But from these restrictions will at the same time proceed several kinds of grave errors. In the first place, since the restrictions are not explicitly recognized, they often are not carried out in a manner scientifically profitable; then, the result, however true, may nevertheless be trivial and unsuggestive. For instance, a series of experiments was recently executed by one of our best known psychologists and ended—to his apparent satisfaction—in showing that some children's school-order was largely correlated with their height, weight, and strength. As, however, no steps had been taken to exclude the variations due to difference of age, the only reasonable conclusion seemed to be that as children grow older they both get bigger and go up in the school! Such explanation turned out in fact to probably be the true and sufficient one.

The next fault to be feared is equivocality. For even if the controlling under-thought be good, yet its indistinctness in the mind of the experimenter causes the restriction to be carried out so unsystematically, that the results inevitably become ambiguous and fruitless.

The last is that, even with the clearest purpose, this specialization of the correlation is an exceedingly difficult matter to execute successfully. Only by a profound knowledge of the many factors involved, can we at all adequately exclude those irrelevant to our main intention.

Now, all such elements in a correlation as are foreign to the investigator's explicit or implicit purpose will, like the attenuating errors, constitute impurities in it and will quantitatively falsify its apparent amount. This will chiefly happen in two ways.

4. "Constriction" and "Dilation."

Any correlation of either of the considered characteristics will have been admitted irrelevantly, if it has supervened irrespectively of the original definition of the correspondence to be investigated. The variations are thereby illegitimately constrained to follow some irrelevant direction so that (as in the case of Attenuation) they no longer possess full amplitude of possible correlation in the investigated direction; the maximum instead of being 1 will be only a fraction, and all the lesser degrees of correspondence will be similarly affected; such a falsification may be called "constriction." Much more rarely, the converse or "dilation" will occur, by correlations being irrelevantly excluded. The disturbance is measurable by the following relation:

$$r_{pq} = \frac{r'_{pq}}{\sqrt{1 - r^2_{pv}}}$$

where r'_{pq} = the apparent correlation of p and q, the two variables to be compared,

r_{pv} = the correlation of one of the above variables with a third and irrelevantly admitted variable v.

and r_{pq} = the real correlation between p and q, after compensating for the illegitimate influence of v.

Should any further irrelevant correlation, say r_{pw}, be admitted, then

$$r_{pq} = \frac{r'_{pq}}{\sqrt{1 - r^2_{pv} - r^2_{pw}}}$$

In the reverse case of "dilation,"

$$r_{pq} = r'_{pq} \cdot \sqrt{1 - r^2_{pv} - r^2_{pw}}$$

These formulæ will be easily seen to be at once derivable from the relations stated on pages 74 and 75. Small, irrelevant

variations evidently do not affect the result in any sensible degree, while large ones are capable of revolutionizing it.

The following is an actual illustration of this constriction. I was investigating the correspondence between on the one hand intelligence at school lessons and on the other the faculty of discriminating musical pitch. The correlation proved to be 0.49. But, upon inquiry, it turned out that more than half of the children took lessons in music and therefore enjoyed artificial training as regards pitch; here, then, was a powerful cause of variation additional and quite irrelevant to the research, which dealt with the correspondence between the two natural faculties. When this disturbant had once been detected, there was no difficulty in eliminating its influence by the above formula; the correspondence between pitch discrimination and music lessons was measured at 0.61; so that the true required correlation became

$$\frac{0.49}{\sqrt{1 - 0.61^2}} = 0.62.$$

In this particular case, the more desirable course was open of eliminating the constriction, *practically*, by confining the experiment to those children who were learning music and therefore were on a sufficient equality as regards the training. The correlation then gained in this purely empirical way exactly coincided with the former result, being again 0.62.

5. "Distortion."

Whereas Attenuation and Constriction have wholly tended to reduce the apparent correlation, and Dilation to enlarge it, we now come to a third kind of impurity that may equally well reduce or enlarge. Its effect is thus analogous to the first consequence of accidental errors discussed in the first part of this article, but, unlike the latter, this Distortion does not in the least tend to eliminate itself in the longest series of observations.

Distortion occurs whenever the two series to be compared together both correspond to any appreciable degree with the *same* third irrelevant variant. In this case, the relation is given by

$$r_{pq} = \frac{r^1_{pq} - r_{pv} \cdot r_{qv}}{\sqrt{(1 - r^2_{pv})(1 - r^2_{qv})}} \quad [1]$$

where r^1_{pq} = the apparent correlation between p and q, the two characteristics to be compared,

r_{pv} and r_{qv} = the correlations of p and q with some third and perturbing variable v,

[1] This same formula has already been arrived at, though along a very different route, by Yule. See Proc. R. S. L., Vol. LX.

and r_{pq} = the required real correlation between p and q, after compensating for the illegitimate influence of v.

Should the common correspondence with v have been irrelevantly excluded instead of admitted, the relation becomes

$$r_{pq} = r^1_{pq} \cdot \sqrt{(1 - r^2_{pv})(1 - r^2_{qv})} + r_{pv} \cdot r_{qv}$$

In the course of the same investigation above alluded to, but in another school, the correlation between school intelligence and discrimination of pitch turned out to be —0.25, so that apparently not the cleverer but the stupider children could discriminate best! But now it was observed that a superiority in discrimination had been shown by the older children, amounting to a correlation of 0.55; while, for a then unknown reason, the schoolmaster's estimate of intelligence had shown a very marked (though unconscious) partiality for the younger ones, amounting to a correlation of 0.65. Hence, the true correlation reckoned out to

$$\frac{-0.25 - 0.55 \times (-0.65)}{\sqrt{(1 - 0.55^2)(1 - [-0.65]^2)}}$$

= + 0.17. This latter low but direct correlation was — under the particular circumstances of the experiment — unquestionably about correct; so that the one originally observed of = -0.25 would have been entirely misleading.

6. Criticism of Prevalent Working Methods.

So far, our illustration of systematic deviation has been confined to instances taken from personal experience. But it might perhaps be thought that other workers avoid such perversions of fact by the simpler method of common sense. Unfortunately, such does not seem to have been at all the case; not once, to the best of my knowledge, has any partial association between two psychological events been determined in such a way as to present any good evidential value—these are strong terms, but, I think, hardly exaggerated.

Psychologists, with scarcely an exception, never seem to have become acquainted with the brilliant work being carried on since 1886 by the Galton-Pearson school. The consequence has been that they do not even attain to the first fundamental requisite of correlation, namely, a precise quantitative expression. Many have, indeed, taken great pains in the matter and have constructed arrays of complicated numerical tables; but when we succeed in orienting ourselves in the somewhat bewildering assemblage of figures, we generally find that they have omitted precisely the few facts which are essential, so that we cannot even work out the correlation for ourselves.

This lack of quantitative expression entails far more than merely diminished exactitude. For, in consequence, the ex-

perimenters have been unable to estimate their own results at all correctly; some have believed themselves to demonstrate an entire absence of correspondence, when the latter has really been quite considerable; whereas others have presented to the public as a high correlation what has really been very small and often well within the limits of mere accidental coincidence; these limits they have had no means of determining, and moreover their data were usually obtained in such a way as to make it unnecessarily large.

Seeing, thus, that even the elementary requirements of good correlational work described in the first part of this article have been so generally deficient, we cannot be surprised to find that the more advanced refinements of procedure discussed in the second part have been almost wholly unregarded; so that the final results are saturated and falsified with every description of impurity. In this respect, unfortunately, it is no longer possible to hold up even the Galton-Pearson school as a model to be imitated. The latter must now perform the very different office of saving us from detailed criticism of inferior work, by enabling us to form an opinion as to how far the defect permeates and vitiates even the best existent correlational research.

As example, we will take Pearson's chief line of investigation, Collateral Heredity, at that point where it comes into closest contact with our own topic, Psychology. Since 1898 he has, with government sanction and assistance, been collecting a vast number of data as to the amount of correspondence existing between brothers. A preliminary calculation, based in each case upon 800 to 1,000 pairs, led, in 1901, to the publication of the following momentous results:

COEFFICIENTS OF COLLATERAL HEREDITY.

Correlation of Pairs of Brothers.

PHYSICAL CHARACTERS.		MENTAL CHARACTERS.	
(Family Measurements.)		(School Observations.)	
Stature	0.5107	Intelligence	0.4559
Forearm	0.4912	Vivacity	0.4702
Span	0.5494	Conscientiousness	0.5929
Eye-color	0.5169	Popularity	0.5044
(School Observations.)		Temper	0.5068
		Self-consciousness	0.5915
Cephalic index	0.4861	Shyness	0.5281
Hair-color	0.5452		
Health	0.5203		
Mean	0.5171	Mean	0.5214

Dealing with the means for physical and mental characters, we are forced to the perfectly definite conclusion, *that the*

mental characters in man are inherited in precisely the same manner as the physical.[1] Our mental and moral nature is, quite as much as our physical nature, the outcome of hereditary factors.

Now, let us consider how these coefficients of correlation will be affected by our "systematic deviations." To begin with, there is the "Attenuation" by errors; since it evidently cannot be assumed that the schoolmasters' judgments as to conscientiousness, temper, etc., are absolutely infallible. On page 90, it has been shown that deviation from this source may be estimated by the following formula:

$$r_{pq} = \frac{r_{p'q'}}{\sqrt{r_{p'p'} \cdot r_{q'q'}}}$$

To ascertain $r_{p'p'}$ and $r_{q'q'}$, I am aware of no precise data beyond that found in some experiments of my own, where the independent intellectual gradings for the same series of subjects correlated with one another on an average to the amount of 0.64. As on other occasions very competent persons have estimated this to be as much as should be expected, and as intelligence is about the most easily gradable of all the mental qualities mentioned by Pearson, there is so far no reason to suppose that his "great number of masters and mistresses" did on the whole any better. Hence, even *if* we could assume that the mistakes in estimating one brother were independent of the mistakes in estimating the other, then the true correlation would be about, not 0.5172, but $\frac{0.5172}{\sqrt{0.64 \times 0.64}} = 0.81$, an extent of difference that seriously modifies our impression of exactitude from all these coefficients to four places of decimals. When we further consider that each of these physical and mental characteristics will have quite a different amount of such error (in the former, this being probably quite insignificant), it is difficult to avoid the conclusion that the remarkable coincidence announced between physical and mental heredity can hardly be more than mere accidental coincidence.

Let us next proceed to irrelevant correlation, and take for our theme postnatal accidents connected on the one side with brotherhood and on the other with the mental qualities. Pearson's primary intention seems to have been to make his correlation as "universal" as possible, and in one place he expressly mentions that education is among the causes contributory to variation. Hence, he is no more than consistent, in that he forms his correlation without regard to the fact that the correspondence between the brothers' "conscientiousness," "popu-

[1] The italics are Pearson's.

larity," etc., must be in great measure due to their coming under the same home influences. But such a correlation can scarcely be accepted as scientifically valuable. For we do not really know anything precise about the assimilating effects of heredity, when our observed correspondence is perhaps chiefly due to the brothers having been similarly brought up — or even to such accidents as their being equally well dressed and having the same amount of hampers and pocket-money. Still less can we, then, fairly compare such a result with that obtained from physical measurements, where common home life has little or no effect. The factor of post-natal accidents, therefore, cannot but be regarded as *irrelevant*, and consequently the coefficients of correlation must be taken as hopelessly "distorted."

But even consistence cannot be upheld throughout the matter. For though the effect of post-natal life has thus been admitted with regard to education at home, it has perforce been excluded as regards public education. For only those brothers have been compared together who are at the same school; the coefficients of correlation would certainly diminish if those also could be included who are living in a totally different manner, have gone to sea, etc. The correlations are therefore also illegitimately "dilated."

If this work of Pearson has thus been singled out for criticism, it is certainly from no desire to undervalue it. The above and any other systematic errors are eventually capable of adequate elimination, and this article has itself, it is hoped, been of some use towards that purpose. Such correction will no doubt necessitate an immense amount of further investigation and labor, but in the end his results will acquire all their proper validity. My present object is only to guard against premature conclusions and to point out the urgent need of still further improving the existing methodics of correlational work, a method of investigation which he himself has so largely helped to create and by means of which he is carrying light into immense regions hitherto buried in the obscurity of irresponsible speculation. The fundamental difference between his procedure and that here recommended, is that he seeks large natural samples of any existing series sufficiently homogeneous to be treated mathematically; whereas here smaller samples are deemed sufficient, but they are required to be artificially selected, ordered, and corrected into full scientific significance. His methods are those of pure statistics; those inculcated here may be more aptly termed "statisticoids."

7. Number of Cases Desirable for an Experiment.

This leads us to the important question, as to how many cases it is advisable to collect for a single series of experiments. In actual practice, the greatest diversity has been apparent in

this respect; many have thought to sufficiently establish important correlations with less than ten experimental subjects, while others have thought it necessary to gather together at least over a thousand.

Now, a series of experiments is a very limited extract, whose disposition is, nevertheless, to be accepted as a fair sample of the whole immense remainder. Other things equal, then, the larger the sample, the greater its evidential value and the less chance of a mere occasional coincidence being mistaken for the permanent universal tendency.

This danger of accidental deviation has been discussed in the first part and there shown to be strictly measurable by the "probable error." We there saw, also, that this danger can never be entirely eliminated by *any sample however large*, so that it is necessary to accept some standard less rigorous than absolute certainty as sufficient for all practical purposes; usually, the danger of mere chance coincidence is considered to be inappreciable when a correlation is observed as much as five times greater than the probable error, seeing that mere chance would not produce this once in a thousand times. Hence, evidently, the accidental deviation depends, not only on the number of cases, but also on the largeness of the really existing correspondence; the more perfect the latter, the fewer the cases that will be required to demonstrate it conclusively; and this tendency is augmented by the fact that the probable error, besides varying inversely with "n," does so to a further extent with "r" (see formula). It was shown in the same part that the size of the probable error also varies according to the method of calculation—and to such an extent that twenty cases treated in one of the ways described furnish as much certitude as 180 in another more usual way. If the common trifold classification be adopted, an even greater number is required to effect the same purpose; and if the correlation be not calculated quantitatively at all, but instead be presented in the customary fashion to the reader's general impression, then no number of cases whatever appear sufficient to give reasonable guarantee of proof.

While thus the number of subjects is not by any means the sole factor in diminishing even the accidental deviation *it has no effect whatever upon the far more formidable systematic deviation*, except that it indirectly leads to an enormous augmentation thereof. When we are taking great pains to be able to show upon paper an imposing number of cases and a diminutive probable error, we are in the self same process most likely introducing a systematic deviation twenty times greater.

From all this, we may gather that the number of cases should be determined by the simple principle, that the measurements to be aggregated together should have their error brought to

the *same general order of magnitude*. An astronomical chronometer, with spring-detent escapement, is not the best travelling clock; nor is there any real advantage in graving upon a milestone (as has actually been done by an infatuated mathematician!) the distance to the nearest village in metres to three decimal places. Now, the present stage of Correlational Psychology is one of pioneering; and, instead of a few unwieldy experiments, we require a large number of small ones carefully carried out under varied and well considered conditions. At the same time, however, the probable error must be kept down to limits at any rate small enough for the particular object of investigation to be proved. For such a purpose a probable error may at present be admitted without much hesitation up to about 0.05; so that, by adopting the method of calculation recommended, two to three dozen subjects should be sufficient for most purposes. The precision can always be augmented subsequently, by carrying out similar experiments under similar conditions and then taking averages. Only after a long preliminary exploration of this rougher sort, shall we be in a position to effectually utilize experiments designed and executed from the very beginning on a vast scale.

PROFESSOR CATTELL'S STATISTICS OF AMERICAN PSYCHOLOGISTS.

By I. MADISON BENTLEY, Cornell University.

I should like to comment on certain points in Professor Cattell's recent census returns, published in the last number of this *Journal*. Criticism of the returns is difficult, both because they form a part of a more comprehensive report not yet published, and because the author's interpretation of the census figures is cautious and conservative. There are, however, two or three matters of interpretation upon which difference of opinion may, I believe, fairly be held.

(1) I am inclined to think that too strong emphasis is laid upon position in order of merit, as determined, in each case, by ten judgments. The interpretation seems to imply that the judges were individually capable of making only gross, not delicate, discriminations of merit. A complete concurrence, *e. g.*, is represented (position one) by a wide gap in the table. But this representation is just only if the gap reappears in the individual judgments. *Degree* of difference does not, however, seem to have been taken into account by the judges. This is simply an illustration. My point is, that more is got out of the average than the individual factors warrant. Another illustration of the same thing appears in the fact that the average assumes equal validity for all judgments. Now the admission is made that the judges did "not possess equal information or judgment" and, also, that "many of those who made the arrangement stated that they had but little confidence in its validity." I do not see how, under these circumstances, 'validity of judgment' can be measured, as the author proposes, by an m. v. of individual judgments from the average of the ten observations. The best informed and most judicious observer may have been just the one to vary most widely from the average.

(2) In grading men of so young a science as psychology, it should be noted that "contributions to the advancement" of the science (the meaning of 'merit' accepted in the statistics under discussion) depend not only upon age but upon length of service and upon the time at which reputation is acquired. M's contributions of twenty-five years may give him fourth place, let us say, while N's contributions, covering five years (perhaps at a different stage of the science), give him twelfth

place. It is, I take it, much more difficult to get a wide reputation in psychology now than it was ten or fifteen years ago. It seems unjust, at all events, to designate M— on the basis of his position in the table—a 'moderate genius,' and N, a 'man of talent.' Length of service and date of reputation may have been taken into account by Professor Cattell's judges; I see no evidence that they were.

(3) Similar allowance should be made for Table III, which gives geographical distribution of psychological students. In comparing the number of psychologists graduated from various institutions, we must take into account that one college or university has taught psychology five years, another, fifteen years; that one has only undergraduate courses in the subject, another, graduate courses, as well; that one has required courses, another, only electives; that one has, in proportion to its size, a large psychological faculty, another, a small faculty. These are factors that we ought not, perhaps, to expect to find in a broad interpretation of the statistical results, but they are worth noting, if only to show the limitations to which the figures are subject.

I have not meant, in commenting on Professor Cattell's statistics, to throw doubt upon the validity of the method. I should venture, rather, to suggest that the method be further elaborated and refined. The first report upon the returns leads me to think that elaboration and refinement will make the method still more useful. Subsequent reports may, however, prove that the modifications suggested were already under consideration.

NOCTURNAL EMISSIONS.

Knowing how much harm is often done to young men by the injudicious, nay criminal, advice of young physicians and others, not to speak of the iniquitous advertising quack, and on the other hand how much good is done by a frank assurance that the "symptoms" so often feared are purely physiological and rendered abnormal only by morbid introspection, I, with some natural hesitation, submit this article in the hope that it may be widely read and may do something toward mitigating a real social evil.

It is well known to physicians that a great deal of worry and misery is caused in young people by a lack of knowledge on their part, and on the part of their parents, regarding sexual matters. One great source of anxiety is nocturnal seminal emissions and the sexual or erotic dreams that commonly accompany them. These are regarded by ignorant youth and parents alike as a sign of depravity, and the consequences of this view are deplorable, physically, mentally and morally. Most physicians, and many persons who, like myself, are not physicians could give illustrations of the truth of this statement. Knowing this, and finding so much diversity of opinion regarding the subject, the present writer, a bachelor who has no record as a rake, undertook to record his own emissions—involuntary of course—and began to keep a record of them and of such accompanying dreams as he could recall early in October, 1895, when just turning thirty. This I have continued to do to the present (Sept. 30, 1903), namely eight years. As I know of no previous record of this kind and scope,[1] I think it worth publishing for the information of the physiologist, the psychologist and the physician, and indeed for all men, for it should have an interest for all whether married or unmarried.

I shall first give a table showing the number of emissions per month throughout the whole period, and then a curve showing the rise and fall of the number of emissions per calendar month on an average.

From the table it is evident that the number of emissions per year is pretty constant, varying between thirty-seven and fifty, or an average of between three and four per month

[1] While this article was printing, my attention was called to the following previous articles on the subject. Perry Coste: *Sexual Periodicity in Men*, in Havelock Ellis's Psychology of Sex, Vol. II, pp. 251-266; which gives average per year as 37. Nelson, Julius: *A Study of Dreams*, *Am. Jour. of Psy.*, May, 1888, Vol. I, pp. 367-401 (especially pp. 390-401); which gives curve of nocturnal emissions ("ekbole").

YEAR.	Jan.	Feb.	Mar	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec	Totals
1895										2	[illegible]	3	7
1896	4	4	2	6	[illegible]	5	5	7	2	2	6	2	50
1897	4	5	[illegible]	4	4	[illegible]	9	3	[illegible]	3	7	4	49
1898	3	4	3	2	3	3	5	[illegible]	3	3	[illegible]	2	39
1899	3	2	4	2	2	6	7	3	1	1	4	2	37
1900	3	[illegible]	5	2	[illegible]	5	1	2	3	7	1	4	39
1901	5	6	6	6	2	1	7	3	3	6	2	[illegible]	49
1902	3	3	3	5	5	4	2	2	3	3	2	3	38
1903	2	1	2	4	4	3	0	3	2				21
Totals.	27	27	27	31	29	[illegible]	36	25	18	27	30	24	329
Average.	3.37	3.37	3.37	3.88	3.62	3.5	4.50	3.12	2.25	3.37	3.75	[illegible]	41.12

throughout the time, except during the last year, when for the nine months recorded the average is a little less. This falling off may be due to the unusual demands made upon the system to repair an injury I received in February, which crippled me for several months. The exact average per month for the eight years is 3.43. That is to say the writer's normal or physiological sexual capacity is between three and four emissions per month. This capacity will no doubt vary greatly in different individuals. In some it will be greater, in others less than this, but there is decidedly a physiological limit. There is here a warning both to the unmarried masturbator and the married incontinent, who are equally foolish and blameworthy.

The average curve is also interesting as showing a spring and summer rise in the number of emissions and a corresponding fall, naturally following upon the seasonal welling up of life. Such a seasonal phenomenon is another link that unites us with the rest of organic creation.

The emissions, besides varying greatly in amount, are very irregular in time. The least interval between them was one day—not counting two taking place the same night, which

occurred, but very rarely. The interval of one day occurred in about 8.5 per centum of the cases. Forty-one per cent. took place in intervals of one, two, three or four days, fifty-nine per cent with intervals of a week or less. Thirty per cent. took place in intervals of from eight to seventeen days, and but eleven per cent. with longer intervals. The longest interval between emissions was forty-two days. While both the amount and the frequency seemed to be influenced slightly by conditions of temperature, food, sexual excitement, etc., the influence was only temporary and made no difference in large periods of time. It has been said that urinating will relieve the pressure and quiet erection. I gave this a fair trial for a long period and found no difference in the net result, though sometimes an emission might be thereby postponed a day or so. Getting out of bed and walking up and down to allay erection was of similarly temporary effect. Illness, however, or poor condition, as also over-work and loss of sleep, certainly tended to make the emissions less frequent.

The time at which the emissions took place was generally in the early morning. Frequently I could not tell just when they occurred, as I knew nothing of it till I awoke. Generally, however, the emissions were accompanied by sexual dreams, which I was able to recall more or less clearly and out of which I sometimes awoke at the orgasm. Inhibition was very seldom possible and never more than temporary. I need scarcely say that the emission was never induced. I examined it once under a microscope and saw numbers of spermatozoa, proving it to be true semen.

The emissions, as I have said, were generally accompanied—or rather preceded—by dreams of a more or less erotic nature. Needless to say that legs and breasts often figured prominently in these dreams, the other sexual parts, however, very seldom and then they turned out to be male organs in most cases. There were but two instances of copulation dreamt. Girls and young women were the usual *dramatis personæ*, and, curiously enough, often the aggressors. Sometime the face or faces were well known, sometimes only once seen, somtimes entirely unknown. The orgasm occurs at the most erotic part of the dream, the physical and psychical running parallel. This most erotic or suggestive part of the dream was very often quite an innocent looking incident enough. As for example: While passing a strange young woman overtaken on the street, she calls after me some question. At first I pay no heed, but when she calls again, I hesitate whether to turn back and answer or not—emission. Again, walking beside a young woman, she said, "Shall I take your arm?" I offered it and she took it entwining her arm around it and raising it high—

emission. I could feel stronger erection as she asked the question. Sometimes a word was enough, sometimes a gesture. Once emission took place on my noticing the young woman's diminished finger-nails. Another example of fetichism was my being curiously attracted in a dream by the pretty embroidered figure on a little girl's dress. As an illustration of the strange metamorphoses that occur in dreams, I one night in my dream (I had been observing partridges in the summer) fell in love with a partridge, which changed under my caresses to a beautiful girl, who yet retained an indiscribable wild-bird innocence, grace and charm—a sort of Undina! Imaginative writers doubtless owe much to their dreams, in which the imagination has such free play. Sometimes the effort was made to inhibit the tendency to emission, but this was very seldom successful. Occasionally inhibition was due to the entrance (in dream of course) of a third person upon the scene. I did not find that the position of the body in sleep mattered much. Generally I was on my back, but sometimes on my side and rarely on my stomach. If I went to bed late very tired or unable to sleep much for thinking, the usual morning erection would generally not take place. Sometimes the erotic dream and emission left a strained or tired and unpleasant feeling behind; at other times I felt refreshed, relieved and the better for it. The erotic dream and emission frequently seemed to be the climax to a gradually increasing feeling of well-being or euphoria lasting some days.

Throughout these years my health has continued very good with rare exceptions, generally in spring, when I have suffered for short periods from tonsilitis; and my weight has varied but little.

LITERATURE.

AN EXAMINATION OF HOFFDING'S THEORY OF RELIGION.

In his recent work on the Philosophy of Religion, Professor Höffding maintains the thesis that the essence of religion is a belief in the persistence of value. The indication of this thesis is not by any means the only purpose of the work, although it is a conspicuous feature of it. The present paper does not aim to review the work as a whole, but simply to examine the meaning and validity of this theory of the nature of religion.

That faith in the conservation of value constitutes the essence and ideal of all religion, is a proposition at once fascinating and baffling. It seems to bring religion at a stroke into line with physics and its doctrine of the conservation of energy. At the same time this very parallel makes the expression a difficult one to understand. Energy, from the point of view of the physicist, whatever the metaphysical may think of it, is an entity. It is clear enough what is meant, when the physicist tells us that the total quantity of energy remains constant under all changes of form. But we do not conceive of value as an entity. It is not a thing but a quality, and not even an objective quality at that, but the quality of certain things in their relation to beings possessed of an affective consciousness. In short, value is a ratio. What sense, then, can we attach to the phrase: conservation of value? We can best get at Professor Höffding's meaning if we look at some of the passages in which he uses it. The first preliminary statement of the theory is given in the introduction as follows: "If religious ideas have no value as knowledge, then the value which possibly they do possess, must consist in the fact that they bring to expression other sides of the soul's life than the intellectual. We must seek, then, a description of the religious life of the soul; particularly of the relation of the ideas to religious experience and religious feeling. In this way it will be shown that religion in its innermost nature has to do, not with the *understanding* of existence, but rather with the *valuation* of it, and that religious ideas express the relation in which actual existence, as we know it, stands to that which gives to life its highest worth for us. The kernel of religion, according to the hypothesis, to which we are impelled, is a belief in the persistence of value in the world (*ein Glaube an die Erhaltung des Wertes*). This belief appears in great representations of perceptual imagery in the popular religions, particularly in the highest of them. Likewise, in those men who stand outside every popular religion, such a belief as this can live even if it is not here set forth in definite form.

"The transition from the psychological side of religion to the ethical is brought about naturally by the question, what ethical value it has that the persistence of value is believed in. Ethics has to do with the production of values, and we cannot deny the possibility that the work of producing values leaves neither time nor strength to spend in thinking of their persistence." In another passage he says: "The religious problem is concerned not merely with the persistence of value in the human world. Not only a psychological, but also a cosmological question is presented—the question as to the relation to existence as a

whole of what appears to man of the highest worth. Is there a connection of values with the laws and forces of existence? Are, perhaps, even these laws and forces determined ultimately by the highest values? Or, perhaps, can we attribute to the concept of value no validity at all outside the sphere of human life?"

"The hypothesis which we shall later seek to establish," says Höffding, "rests upon this: that the principle of the persistence of value is the peculiar religious axiom which is expressed in various ways in the various religions and by the various religious standpoints." Again, he says, "If I undertake to show that the principle mentioned is the fundamental thought of all religion, this attempt will be none the less successful because it is manifest that no religion expresses the principle with clearness and consistency. It will suffice if an expressed need or expressed tendency to lay hold of this fundamental thought can be shown, so that the standard for estimating the worth of religions in their mutual relations, will be the degree in which they can express and carry out the principle. When the persistence of value is spoken of, it might be understood as if value did not disappear, but existence always contained value, whether it increases or decreases, or does both by turns. I take the expression persistence of value, however, in analogy with the expression persistence of energy, so that the principle asserts the continued persistence of value throughout all changes of form. It will therefore be necessary, perhaps, to distinguish between potential and actual value as we distinguish between potential and actual energy, and the one distinction is just as clear and appropriate as the other.

"The nature of a being determines its needs, and the needs determine what has value for it. Accordingly the religious axiom indicates the necessity that the character of a religion be determined by the nature and needs of its adherents. For one cannot believe in earnest in the persistence of value which he does not know in some measure from his own experience."

One of the first questions that naturally arise on considering this theory is: Does, then, a belief in the persistence of any sort of value constitute religion in Höffding's view? Is it some special kind of value, or is it value in general; value in the abstract that he means? That no determination of the nature of the value in question is given in the oft repeated formula, "Belief in the persistence of value," is indeed, confusing. In the course of the exposition, however, we find religious values differentiated from the other values in two ways. In the first place it is a belief in the persistence of the *highest* values which makes religion. It is not, however, the highest in any ideal or absolute sense, but simply the highest for us, and this is, perhaps, why Höffding does not put in the term highest in his formal statement of the principle. The Greek and the Greenlander may each have religion, according as he believes in the persistence of the value which is to him the highest, although the thing of highest worth may be eternal beauty for the one, and unlimited blubber for the other. Religion presupposes that man has some experience of value. The content of religion is always dependent upon man's experience, in particular the experience of what he has found worthful. "The values," Höffding says, "in whose persistence man believes, will be those which are to him the highest." And so the various religions may present the greatest differences, and yet each in its own way express a faith in the persistence of value. The opposition between the lower and the higher religion is of the greatest weight practically, but theoretically they are all the same. Lower and higher alike express in some measure the characteristic religious axiom—belief in the persistence of value.

Again, religious values have a certain derivative or secondary character as compared with other values, the primary values. Among our direct or primary values Höffding distinguishes two groups. One group of these values goes along with self assertion from its most elementary up to its most ideal forms. The other group of values is connected with devotion to beings, relations, and tasks, which reach out beyond the conditions of isolated self-assertion. To this second group belong the ethical, æsthetic, and intellectual feelings. Religion depends upon the existence of a third group of values, indirect or secondary values, which depend upon the values of the first two groups. The values of the third group spring from our interest in winning and preserving in existence the primary values. Existence appears to men as a battlefield on which the fate of values is decided. Existence is a great drama in which man is at once both a player and a spectator. Were he only a player, his entire energy and interest would be absorbed in his own part in the play. He would have no time or strength for, or interest in, the course of the drama as a whole. Were he, on the other hand, only spectator, his attitude would be purely intellectual or æsthetic. But if he is both, he will have values himself which are in conflict with the play. Besides his participation in it, the picture, also, which he forms of the course of the drama, will influence him and determine his attitude. He will feel himself drawn into the great order and stream of things with his entire inmost being, and for the sake of the highest values known to him, so that there will arise in him a most lively feeling of pleasure, or pain. In its immediate form this feeling discharges itself in utterances of hope and fear, of admiration and honor, of joy and sorrow. Such utterances are in all fields the simplest judgments of value that there are. "This feeling determined by the fate of values in the struggle for existence," says Höffding, "is the religious feeling." This feeling, accordingly, is determined by the relation of value to reality. This relation, as it appears to man, determines the value which man ascribes to existence. Accordingly, the religious judgments are secondary judgments of value. In comparison with the primary judgments of value, by which the first two groups of values are expressed, they are derived. So much for the differentation of the religious values from the other values. Another question of paramount interest in considering any proposed theory as to the nature of religion is: How does the theory in view square with the actual form which religion has taken in history? Höffding submits to a careful and somewhat extended analysis the typical manifestations of the religious consciousness. He finds in all his religious axiom present implicitly if not explicitly. Indeed, the axiom is rather an unconscious ideal which each embodies in its own way and in greater or less measure. As we breathe without knowing the physiological laws of respiration, as the common consciousness acts in accordance with the laws of the association of ideas without knowing them, so the religious consciousness unconsciously manifests the principle of faith in the persistence of value. While all manifest, or at least tend to manifest this principle in some degree, no actual religion expresses it in its ideal form. "For the complete carrying out and verification of the belief in the persistence of value," says Höffding, "it would be required that nothing should occur in the world process as mere means or mere possibility, to say nothing of a sheer hinderance, that, on the contrary, whatever possesses immediate value should have always at the same time immediate value, and that all hinderances should, at the same time, be means also." Höffding frankly states that no actual religion realizes the principle in this ideal form; one wonders if he is acquainted with Christian Science. One of the two fundamental syllogisms on which Mrs. Eddy builds her

system is, "God is all—God is good, therefore, all is good and there is no evil." This would seem to afford an almost perfect realization of Höffding's principle in the ideal form. Höffding shows a most extensive knowledge of the historical manifestations of religion, and of the biographies of the great religious personages. One wonders at times, however, how his views might be affected if he were to become equally familiar with the varied and abundant florescence of the religious consciousness on the free soil of America. In spite of the optimism of the principle of the persistence of value in its ideal form, Höffding admits that it does not escape the difficulty of the problem of evil. For even if it be granted that all hinderances and all opposition were necessary means to the development and preservation of the worthful, still the question would arise why any means at all should be requisite, why the worthful should not be and prevail immediately, why there should be any difference or strife between value and reality?

It might appear as if the hypothesis of the persistence of value would be quite inconsistent with any pessimistic form of religion, but such, Höffding argues, is not the case. The pessimist must admit that there is something of worth in the world, but that it is to be won only by hard fighting and unavoidable suffering. He fixes his attention, before everything else, on the struggle and suffering, but still he necessarily has a belief in the possibility that the worthful can be secured by persistent fighting and suffering. No religion and no philosophy maintains an absolute pessimism. Buddha points to the possibility tf attaining nirvana which is not at all to be identified with annihilaoion. Schopenhauer sees escape from disharmony in artistic and scientific activity, in sympathy and religious asceticism. An absolute pessimism would be valid only for those beings which some religions damn to eternal pain. But this eternal pain is not the entire content in any religion. The effort is always made to show that the highest values are to be attained not only in spite of, but even because of the eternal pain in some part of existence. The complete opposite of all religion would be neither optimism nor pessimism, but, on the contrary, neutralism; the view of things, according to which all valuation beyond the field of human conduct falls away, and man regards the course of the great world process only as a spectator, feeling himself convinced of absolute indifference towards all that men call worth. But such indifference is, perhaps, more theoretical than possible. Even the mere spectator would feel some intellectual, even if no ethical interest. It would endow existence with some value that it gives joy to his own understanding or contemplation, and his view of the world would be colored involuntarily by the progress or retrogression of such intellectual and æsthetic values.

In this brief survey of Höffding's Theory of Religion, I have endeavored, by means of quotation and paraphrase, to let the theory speak for itself. Time permits only a brief indication of the criticisms that might be offered. In the first place, the analogy suggested between conservation of value and conservation of energy, seems somewhat too far fetched. It may be possible, however, to attach some meaning to this analogy, even though value be a ratio, and energy an entity. A ratio may be conceived as constant even though the objects related are constantly undergoing change. The analogy is helped out by noting the existence of potential values (the pause in music is instanced as an example of a potential value), and the analogy is carried further by noting the transformation which values undergo—as, for example, it frequently occurs that a value which is first mediate comes in time to be immediate. But when we come to the quantitative aspect which plays so important a part in the doctrine of the conservatism of energy, the analogy seems to break down altogether.

The notion of a quantum of value in the universe, and the permanent conservatism of that quantum is wholly elusive. The notion takes form at all only by hypostalising value. Again, we may question whether the principle of the conservation of value offers anything distinctive of religion. We may admit Höffding's success in showing that all religions involve this element, but does not all intellectual effort in whatever sphere, involve a faith in the continuance of values, and involve some sort of conception of the relation between value and reality in the realm of experience, as well as in the transcendental realm?

A belief in the maintenance of empirical values cannot constitute religion. It is only when our faith carries us into the transcendental realm, or, if you please, when we consider the relation of value or of ourselves to reality as a whole, that we come into the religious attitude. Again, granting that a faith in the persistence of value is a universal aspect of religion, we may still ask whether, after all, it can properly be regarded as the *essence* of religion. It seems to me there is a confusion here of effect with cause, or, so to speak, of attribute with substance. Tiele has pointed out, on the basis of his studies in the science and history of religion, that the characteristic of religion subjectively is adoration. Recall, now, Matthew Arnold's formula for the objective side of religion, "The power, not ourselves, that makes for righteousness." Combining these two we may say religion is our adoration of the "Power, not ourselves, that makes for righteousness." Undoubtedly, one outcome of such adoration is faith in the persistence of moral worth, but this confidence is rather a product of religion than religion itself. Again, Höffding's hypothesis fails to account for the moral dynamic in religion. Such a view might answer for certain quiescent, mystical, contemplative forms of religion. But it fails utterly to account for the moral force so characteristic of the active types of religion.

Such a view, further, fails to give religion its place with respect to the other aspects of our spiritual life. Just as, theoretically, God is the principle of unity in the world, so, practically, religion should be the principle of unity in life. We must appeal to our transcendent interest to preserve the proper balance in our several empirical interests. Or, as we may state it, if religion is to be of any value, it must set a criterion for values. In answer to a similar criticism which I made in the review of the work published last March, in the Philosophical Review, Professor Höffding, in a private letter, urges his view that it is ethics whose business it is to furnish a standard of values. But while ethics may properly afford the standard for appraising the value of conduct, we must call upon religion for the standard by which to appraise the relative worth of our several types of values themselves, such as the sensuous, the intellectual, the æsthetic, and the moral. Which of the various kinds of value possible to us shall we seek to realize, and in what proportion? To this practical question, where religion, if anywhere, ought to give us help, a belief in the conservation of value seems to be of no service. If all influence in practical life is to be denied to religion (and this is, perhaps, just what Höffding means to say), then religion is reduced to a merely subjective attitude of the æsthetic type toward reality as a whole. This view is borne out by the view of the future development of religion which Höffding founds upon his theory of its essence. Religion, he thinks, is to become more and more a form of poetic symbolism.

In conclusion, I will call attention to what seems to me one manifest excellence in Höffding's theory. There are two directions in which one may look to find the essence of any group of phenomena that constitute a progressive series. One way is to eliminate all the differ-

ences and seek the common element that is left. This is Herbert Spencer's method by which he finds the essence of religion to consist in a recognition of the inscrutable mystery of things. The second way seeks the essence in the idea that is successively, progressively, but perhaps never completely manifested in the series. The first method attempts to explain the higher by the lower—the second method finds the explanation of the lower only in the higher. The first seeks an elemental essence; the second, an ideal essence. The first might be denominated the logical method; the second, the biological method. It is a pre-eminent merit in Höffding's work that he has adopted the second method. Whatever may be the final estimate of his hypothesis, he is worthy of great credit for his effort to determine the ideal essence of the religious consciousness.

F. C. FRENCH,
Lincoln, Nebraska. University of Nebraska.

Heredity and Social Progress, by SIMON N. PATTEN. New York, The Macmillan Co., 1903. pp. vii, 214. $1.25.

Modern thought accepts the seeming paradox that evolutionary progress owes its origin to adverse conditions of environment. Thus, current biology and economics hold that the moulding factors of evolution are operative chiefly under conditions which are unfavorable to the life of the organism. And current religion teaches that morality thrives in adversity and decays in prosperity. Professor Patten maintains that this conception is fundamentally false. The main argument of his book supports the counter thesis: Progress starts from a surplus, not from a deficit. The acquired characters of one environment create a surplus of energy which evokes new characters; these in turn impel their possessors to seek another environment, in which the maximal benefit of the improved equipment may be reaped.

But how are the new characters evoked? And how do they become permanent possessions of the race? The accumulated surplus is made up of perishable goods only. To make progress secure, this temporary surplus must be transformed into permanent conditions or into mental traits. If such a transformation is impossible, progress can never be more than merely temporary. If it is possible, not only will a permanent progress be assured, but the process of the transformation must portray the course of social progress.

Professor Patten finds that the transformation actually does take place, and in the following manner. The successful artisan provides more food, leisure and protection for his children. Brought up under these conditions, the children acquire greater vitality, increased energy and a fuller development of their natural qualities. The new characters thus acquired beget a disinclination to the humdrum occupation of the father. New environments and new occupations are sought, in which the acquired characters may be utilized. The children become physicians, lawyers and clergymen; and move into a higher class in the social scale.

The essential point, then, in all social progress is the creation of a social surplus. This surplus is not permanent in form but is constantly in circuit, both biologically and economically, always disappearing but ever reappearing in new form. Its successive phases recur in the following order: First there is produced a surplus of energy through the employment of acquired characters; this surplus is next expressed in secondary characters; then a use is discovered for these secondary characters, in which the whole species can share; and finally the species moves into a new environment where the secondary characters are necessary.

The characters acquired by an individual or a generation, are not transmitted directly to its descendants. They gradually become in-

grained in the social fabric and are perpetuated in customs, habits and traditions. But the characters themselves must be reacquired by each succeeding generation. Then, too, it is found that the gradual acquisition of new characters is attended by a one-sided development of the individual. It becomes the function of education to restore uniformity; this it attempts to do, not by eliminating the weak, but by developing and strengthening them.

In the lower organisms, on the contrary, progress is made by means of elimination. But in human society differentiations are conserved and harmonized by a division of labor or of function. Nor are human contests fought out to the death; they are usually decided within the domain of wealth. One party yields when its property is endangered or destroyed, as in modern warfare, or when its material resources are shown to be inferior, as in industrial struggles between nations or classes. Hence, in modern times at least, natural selection acts upon man only indirectly, through his material equipment.

Professor Patten makes a good deal of emotion as a factor in progress. When a herd of deer is attacked by lions the emotion aroused by the slaughter impels the survivors to change their habitat, and possibly their habits and food as well. Emotion narrows choice, limits the range of food, and consequently causes an arrest of development. In the case cited, the adjustment to new conditions, ushered in by the emotive factor, occurs much more rapidly than could be effected by natural selection. National disasters act as a similar check to human progress, in virtue of their emotional effect.

The author assumes, as a matter of course, a thoroughgoing parallelism between biological and economic evolution. The result is that the discussion not infrequently degenerates to mere argument from analogy. Many of his biological conceptions are weird in the extreme: *e. g.*, his conception of the brain as an inclosed ovary, male in woman and female in man (pp. 105 ff.), and his theory of "reduction." Nor is his psychological doctrine less startling; *e. g.*, his treatment of memory, emotion and visualization (pp. 95 ff.). But these lapses do not invalidate his general position. Indeed, these parts of the discussion might have been omitted from the volume without serious loss.

Though the argument fails at times to carry conviction, the treatment has at least the virtue of originality, and will, doubtless, stimulate further discussion. J. W. BAIRD.

The Virgin Birth of Christ. An historical and critical essay by PAUL LOBSTEIN. Translated into English by Victor Leuliette. Edited by W. D. Morrison. G. P. Putnam's Sons, New York, 1903. pp. 138.

This remarkable and interesting little work is to be welcomed in its plain English dress. The author's general conclusion may be stated in his own language if the Virgin Birth of Christ "ceases to remain a real fact, it stands out as the characteristic creation of the faith of the church." "In the light of this two-fold investigation the tradition of the miraculer birth of Jesus vanishes away, or rather resolves itself into a myth created by popular devotion and destined to explain the Divine Sonship of Christ by his supernatural generation. Thus viewed, the conception of our two evangelists is an important landmark in the development of Scriptural Christology. Every attempt made to reconstruct on a dogmatic basis a notion now forever overthrown by exegesis and criticism, has but betrayed the inextricable contradictions of popular orthodoxy. We are, therefore, doing a valuable service to faith by confining the traditional doctrine to its religious import. By laying bare the imperishable truth contained in the Christian symbol, we are remaining faithful to the mind of Jesus,

who bases his own unique communion with God not upon the physical miracle of his supernatural birth, but upon the sovereign election and perfect revelation of the Heavenly Father. If we set aside the dogma which the school has deduced from the stories of Matthew and Luke, it is that we may subscribe with absolute sincerity and joyful assurance to the Johannine saying, echo of our experience and confirmation of our faith: 'Jesus said unto them: I am from above; I am not of this world.'"

The Unwritten Sayings of Christ, by C. G. GRIFFINHOOFE. Edward Arnold, London, 1903. pp. 128.

This is an interesting and somewhat popular account of the words imputed to Jesus, not only in the Apocryphal Gospels but in the writings of some of the early fathers, including the newly discovered logia. It is evident that the writer believes that in many of these we have substanially the very expressions of our Lord.

Les limites du connaissable. La vie et les phénomènes naturels, par FÉLIX LE DANTEC. F. Alcan, Paris, 1903. pp. 237.

This volume is made up of various recent essays of the author, the first and most important being a characterization of the place of life in natural phenomena. Repose is an illusion in the world of brute matter. Chemical reaction, action at a distance, and vibrations at least are continuous. The dimensions of life and its lower limits of size are next discussed, and the forms of movement that the human mind can know. Other briefer chapters deal with Grasset's conception of the limits of biology, the divine, retrograde movement, evolution and its apologists, and knowledge of the future.

Animal Education. An experimental study of the psychical development of the white rat, correlated with the growth of its nervous system, by JOHN B. WATSON. University Press, Chicago, 1903. pp. 122. Price, $1.25.

This is, perhaps, the best study of many that have lately been made of the white rat. The experiments, themselves, are careful, but the significant feature of the work is a comparison of the psychic development of the white rat at different ages, and the correlation of its stages of development with the growth of the inner structure of the brain. Although no momentous conclusions are drawn, close parallelism of psychic growth with that of medullation fails to appear.

Willensfreiheit und moderner psychologischer Determinismus, von ANTON SEITZ. J. P. Bachem, Köln a. Rh. pp. 62.

Die Energie und Entropie der Naturkräfte mit Hinweis auf den in dem Entropiegesetze liegenden Schöpferbeweis, von R. SCHWEITZER. J. P. Bachem, Köln a. Rh. pp. 59.

An Introductory Study of Ethics, by WARNER FITE. Longmans, Green and Co., London, 1903. pp. 383.

This work treats first of scope, method and problems; then of the various forms of hedonism, empirical, scientific, theoretical; their relations to common sense; then of intuitionism or the ethics of conscience; rationalism or the ethics of principle; self realization or the ethics of purpose; idealistic, social theory; idealism as a system of philosophy; idealism and common sense. The third part discusses the moral situation, or the metaphysical from an evolutionary standpoint, and the practical, moral attitude, with illustrations. The book has few references to literature.

Neurologic Progress and Prospects, by F. W. LANGDON. Chicago, 1903. pp. 19.

This author gives a very interesting account of the scientific, and especially the clinical and practical progress of recent years in neurology.

The Wellcome Physiological Research Laboratories. Founded 1894. Walter Dowson, Director. London.

This laboratory is admirably equipped, and this little booklet gives us a very interesting picture of it, with a good account of the work which is thought to be desirable in such institutions.

Grundzüge der physiologischen Psychologie, von WILHELM WUNDT. Fünfte völlig umgearbeitete Auflage. Dritter Band. W. Engelmann, Leipzig, 1903. pp. 796. Unbound, M. 14. Bound, M. 17.

This volume treats of time concepts, feeling concepts and passions, will processes, consciousness and the lapse of concepts, psychic connections, anomalies of consciousness, scientific preconceptions of psychology and its principles. An index is to follow.

Das Problem der Gegebenheit, von PAUL STERN. Grundprobleme der Philosophie. Bruno Cassirer, Berlin, 1903. pp. 79.

In the first part the writer gives us a critique of false presentations and their consequences in empiricism, sensualism, etc. The second part describes the problem of building up the world and mechanical psychology, with special reference to evolution and psychological metaphysics.

The Free-Will Problem in Modern Thought, by WILLIAM HALLOCK JOHNSON. The Macmillan Co., New York, August, 1903. $.75. pp. 94.

Free will is discussed, first with relation to the psychophysic question, then as related to evolution. The third section is on the consciousness of freedom; in the fourth part it is considered as an ethical postulate; and, lastly, its relations to theology are discussed.

The Edwardean. Devoted to the History of Thought in America. Ed. by Wm. H. Squeres, Hamilton College, New York, Oct., 1903. Vol. I, No. 1. $2.00 per yr.

This new quarterly marks the two hundredth anniversary of the birth of Jonathan Edwards, and is to be devoted to the history of thought in America. The articles are glimpses into Edwards's life, the seventy resolutions, Edwards as a thinker, some estimates of his work, and his metaphysical foundations.

St Anselm. Pros. Logium: Monologym. An Appendix in Behalf of the Fool, by GAUNILON and CUR DEUS HOMO. Tr. by Sidney Norton Dean. Open Court Publishing Co., Chicago, 1903. pp. 288. $.50.

Queries in Ethnology, by ALBERT GALLOWAY KELLER. Longmans, Green & Co., New York, 1903. pp. 77.

This little vest pocket manual consists of eight hundred and sixty-nine points or suggestions for those observing primitive people. They are classified under maintenance, perpetuation, gratification, religious and superstitious ideas and uses, the societal system, and contact and modification.

Dissertations on Leading Philosophical Topics, by ALEXANDER BAIN. (Mainly reprints from *Mind*). Longmans, Green & Co., New York, 1903. pp. 277.

These papers, mainly reprints from *Mind*, cover the more important

of the author's incidental contributions to philosophy during the last twenty-five years. Some of the most interesting of these are on the scope of anthropology and its relations to the science of mind, the mutual help of introspection and psychophysic experiment in psychology, physiological expression in psychology, is there such a thing as pure malevolence, definition and problem of consciousness, etc.

Lao-tze's Tao Teh King. The Canon of Reason and Virtue, tr. from the Chinese by DR. PAUL CARUS. Open Court Publishing Co., Chicago, 1903. pp. 138. $.50.

The Open Court Publishing Company is rendering a real service to students of philosophy, religion, and psychology, by placing such standards as these within the reach of the public at such moderate cost. The last is number 55 in the series.

Zur Psychologie des ästhetischen Genusses, von DR. G. WERNICK. Verlag von Wilhelm Engelmann, Leipzig, 1903. pp. 148.

The author first makes some general observations concerning æsthetic effect, then studies the laws of association, reproduction and sensation in their relations to æsthetic feeling, and these three points constitute the substance of his work.

The Philosophy of Auguste Comte, by L. LEVY-BRUHL. Introduction by Frederic Harrison. G. P. Putnam's Sons, London, 1903. pp. 363. $3.50.

We have here an admirable condensation of the four parts or books of Comte's positive philosophy. It was a bold undertaking to compete with the masterly condensation of Harriet Martineau, but it was certainly desirable to have a briefer epitome, and this we have here. It is enough to say that it does not suffer by comparison with Harriet Martineau's work.

The Nature of Man. Studies in Optimistic Philosophy, by ÉLIE METCHINKOFF. English translation edited by P. Chalmers Mitchell. G. P. Putnam's Sons, New York, 1903. pp. 309. $2.00.

The writer first treats of disharmonies in man's nature, then of the attempts to diminish the ills arising therefrom, and in the last part résumés what science is able to do to alleviate the disharmonies of the human constitution, with a characterization of Pasteur and his work, in whose institute the author's own sphere of work lies.

Studies in Logical Theory, by JOHN DEWEY and others. The Decennial Publications. 2nd ser. Vol. XI. Univ. of Chicago Press, Chicago, 1903. pp. 388. $2.50.

This volume contains four papers by the editor, and seven by other people, mostly professors elsewhere, on various logical topics. The book not only has high intrinsic value, and should be indispensable to every logician, but it is an interesting presentation of the work accomplished by one of our leading academic professors and those who have formerly been his students.

Le Movement, par R. S. WOODWORTH. Tr. par Mlle. le Dr. Elvire Samfiresco. Octave Doin, Paris, 1903. pp. 421.

In the first part the author discusses the perception of bodily movements, and in the second part their production. On the whole it is a valuable summary of the condition of our experimental and theoretical knowledge on the subject, with an excellent bibliography, index, etc.

Hypnotism. Its history, practice, and theory, by J. MILNE BRAMWELL. Grant Richards, London, 1903. pp. 477.

Of these fifteen chapters the best are those devoted to the experi-

mental phenomena of hypnosis and its uses in medicine, and best of all a thorough discussion of hypnotic theories. The author's own views here are sound and scientific, and he takes a wholesome stand against the mysticism which has lately crept into the conceptions and discussions of this topic.

L'Année Psychologique, par ALFRED BINET. Vol. 8. Schleicher Frères, Paris, 1902. pp 757.

The first 389 pages are devoted to original articles, sixteen in number; then follow the digests and discussions ending with page 583; the rest of the volume being devoted to titles.

Transactions of the Congress of American Physicians and Surgeons. Sixth Triennial Session held at Washington, D. C., May 12th, 13th, and 14th, 1903. Published by the Congress, New Haven, 1903. pp. 243.

The Critical Review of Theological and Philosophical Literature, edited by S. D. F. Salmond. Vol. XIII, March, 1903. No. 2, pp. 192. Williams and Norgate, London.

Die Einwanderungspolitik und die Bevölkerungsfrage der Vereinigten Staaten von Amerika, von R. KUCZYNSKI. L. Simion, Berlin, 1903. pp. 35.

The Relations of Structural and Functional Psychology to Philosophy, by JAMES ROWLAND ANGELL. The University Press, Chicago, 1903. pp. 21.

Polydactylism in Man and the Domestic Animals, with Especial Reference to Digital Variations in Swine, by C. W. PRENTISS. (Bull. of the Mus. of Comp. Zool., Vol. XL.) Cambridge, Mass., 1903.

Dr. J. W. Wherry (Iowa Medical Journal) attempts to answer the question, "Why have there been so few results from original research in State hospitals for the insane?" This, he thinks, due largely to politics which makes careers so uncertain that even the position of assistant is felt by those who hold it to be tentative, and to the fact that specialists have almost ceased to study insanity *per se* and drifted away from the prime intention of hospitals, which was to shed light upon its origin, prevention and cure. He declares that insanity is not a disease but a condition expressing a mental attitude. Even could we prove that molecular brain change is its cause we should still need to seek a cause of the cause. Cords of histories of cases have been written and even printed, but scientific research begins where history ends. It is not even proven that insanity is a primary brain disease, because function, at least in many cases, seems to precede structural changes. Masses of literature have been written in the hope of some imposing future genius who would find something valuable in it. Bacteriology has little or nothing to do with insanity. Physicians have been led captive of late by the theory that insanity is the result of a brain disease. This has caused an infatuation and has minimized attention to psychic abnormalities, which have no physical symptons or correlates, and has led to the abandonment of the subject by psychological minds.

The Theory of Advertising, by WALTER DILL SCOTT, Ph. D. Small, Maynard & Co., Boston, 1903. pp. 240.

Mr. Scott, who is the director of the Psychological Laboratory at Northwestern University, has in this book made an application of

psychological principles to the theory of advertising. Nearly all of the chapters were originally published in Mokin's Magazine, and have now been collected and given to the public in book form. The author has analyzed a large number of advertisements and points out how their success or failure depends upon the degree in which they follow or deviate from psychological principles. Mr. Scott's theories have, in several cases, been practically tested by business firms, and have proved successful. The book is primarily designed as a guide in advertising, but is interesting to psychologists as a practical application of familiar principles.

Professor Strong on the Relation Between the Mind and the Body, by MORTON PRINCE. The Psychological Review, Vol. X, No. 6, Nov., 1903. pp. 658.

Mr. Prince claims to have anticipated Professor Strong as early as 1888, in his solution of the theory of the relation of the mind to the body. In this discussion he used the following words:

"In other words, a mental state and those physical changes which are known in the objective world as neural undulations, are one and the same thing, but the former is the actuality, the latter, a mode by which it is presented to the consciousness of a second person, *i. e.*, to the non-possessor of it.

"The real question is, not regarding the transformation of matter into mind, but how one state of consciousness comes to be perceived as another state of consciousness, or how a subjective fact comes to be perceived as an objective fact; how a feeling comes to be presented to us as a vibration."

"Physical changes (the thing-in-itself) occurring in a foreign body, as a piece of iron, though giving us our experience of it, must be absolutely unknown to us. Physical changes occurring in our brains are clearly known to us; they are our thoughts, our sensations, and our emotions."

"The common expression that 'every state of consciousness is accompanied with a molecular change in the substance of the brain,' . . . . must be regarded as unfounded and as leading to great confusion and misconception. A feeling is *not* accompanied by a molecular change in the same brain; it is 'the reality itself of that change.' . . . . You cannot correctly say that a feeling is accompanied by a molecular change in the same organism, because this implies two distinct existences, and leads to all the fallacies of materialism.

"The parallelism is between your consciousness and my consciousness of your consciousness, or, what is the same thing, between the consciousness in you and the picture in my mind of neural vibrations."

Dr. Prince regrets that Professor Strong had overlooked his own book, but welcomes him as a newcomer to the pan-psychic doctrine of which his work is a "capital restatement."

Evolution and Adaptation, by THOMAS HUNT MORGAN. The Macmillan Co., New York, 1903. pp. 470.

This volume is in a very different and wider field from that of the author's work on regeneration, and to many it will be a disappointment. Much in the early chapters is certainly a little tiresome and familiar. The statement of Mendel's law and of the mutation of De Vries, of Nägeli's perfecting principle, is very convenient for non-biologists who have not read the original. So is the statement of the doctrine of tropisms and instinct. But in the latter the author appears to know very little of this immense field, and to psychologists, at least, who, perhaps, first turn to this chapter, the disappointment will be most felt. It is convenient, however, to have so many of the prob-

lems of evolution stated in a concise way between two covers. Perhaps the most exasperating feature of the book is the almost complete absence of references.

L'Origine dei Fenomeni Psichici e il loro Significato Biologico, by G. SERGI. (Biblioteca di Scienze Moderne. No. 14.) F. Bocca, Torino, 1904. pp. 366.

Professor Sergi here gathers up in a very interesting way his own essentially evolutionary conceptions of the origin of the soul. Sensibility, movement, memory, are essentially biological functions, and the psychic heredity is as real as that of organism. He gives a valuable account of the psychic function of nutrition and instinct, and traces the development down to the social and religious consciousness, with plenty of space given to the abnormal side of the topic.

The Religious Sense in its Scientific Aspect, by GREVILLE MACDONALD. Hodder & Stoughton, London, 1903. pp. 243.

This work consists of three lectures, the Religion of Service, of Renunciation, of Freedom. The writer draws the illustrations from cuts of the foraminifera, the spongilla, the Venus flower-basket, the daisy, the guilder rose, pearly nautilus. While it cannot be said to add to our knowledge, or to be aggressive or original, it leaves a very pleasant impression from its easy and complacent style.

Gefühl und Bewusstseinslage, von JOHANNES ORTH. Reuther & Reichard, Berlin, 1903. pp. 131.

The writer urges that feeling is an independent psychic phenomenon and attempts to distinguish it from sensation and will, argues that pleasure and pain must still be regarded as feelings, denies specific will feeling, holds that excitement, tension, and rest are not true feelings, postulates a revision of the idea *affekt*, and urges that doubt is not a feeling.

The Philosophy of Hobbes in Extracts and Notes Collated from His Writings, by FREDERICK J. E. WOODBRIDGE. The H. W. Wilson Co., Minneapolis, 1903. pp. 391.

Every student of philosophy will heartily welcome this text of selections, and all those teachers who refer their classes to original authorities in the history of philosophy, will be glad to have the most readable parts in convenient form.

A Non Surgical Treatise on Diseases of the Prostate Gland and Adnexa, by GEORGE WHITFIELD OVERALL. Marsh & Grant Co., Chicago, 1903. pp. 207.

Man's Immortality and Destiny, by ROBERT P. DOWNES. "Great Thoughts" Office, London. pp. 180.

This is one of those books from which the publisher has very carefully scored away everything that can indicate its date. Whether it is a very old book now reprinted, or brand new, is impossible to tell. The theology of it reeks with age. It is poetic and sermonesque.

ERRATA.

Vol. XIV, p. 422 (Commemorative Number, p. 158) in Protocol for Fig. 2:

Question:	*for*	34 mm.	*read*	44 mm.
"	"	3502σ.	"	4532σ.
Error:	"	-470σ.	"	-1500σ.

N. B.—Values given in Table I, Subject S. (p. 425 or 161), are unaffected by the mistake, the protocol as corrected being a part of the data for the *last* record there given.

THE AMERICAN

JOURNAL OF PSYCHOLOGY

Founded by G. STANLEY HALL in 1887.

VOL. XV. APRIL, 1904. No. 2.

THE SOUL—A STUDY OF PAST AND PRESENT BELIEFS.

By L. D. ARNETT.

INTRODUCTION.

The selection of this subject[1] for investigation was not made with the view of settling any of the disputed points as to the nature of the soul, or even of raising the question as to whether man is endowed with a soul, but rather because the writer felt a lack of knowledge of the subject and has taken for granted that other students have the same feeling. As progress is made in any line of industry it is well to "take account of stock" at times and if the "assets" are sufficient the books may be closed, new accounts opened, and the stock increased. The results of this study may not justify the "closing of the books" but they may represent something of the "stock on hand." Students of psychology feel the lack of any definite understanding of the term "soul" as used by psychologists, compared with the meaning attached to it by the ministry. One object of the study is to present the views of these two professions. Another object is that, from the material presented, some definite understanding of the use of the term may at least be suggested. The subject is treated from the historical standpoint. The first section presents the ideas of primitive peoples. For the section on present ideas of the soul, the material of which was collected by means of a questionnaire, the writer desires to take this occa-

[1] The writer desires to express his thanks to Dr. E. F. Buchner, of the University of Alabama, for suggesting the subject, and for valuable advice as to the method of arranging the material; to Dr. G. Stanley Hall and other members of Clark University for valuable suggestions.

sion to thank those who assisted him in collecting the data. The reader may be disappointed when he discovers that no very definite conclusions are reached. But it is hoped that the material will at least prove suggestive for future studies in psychology.

Primitive Ideas of the Soul.

A study of the beginning or origin of any mental trait or even of a social institution must deal more or less with the indefinite. Studies of existing savage and half-civilized races furnish certain data; to lower levels, or earlier stages of mankind we cannot go, and any reference to such state or condition is merely conjecture. The data presented in this study has been gathered from reports,[1] for the most part trustworthy. Yet we cannot vouch for the explanation given in all cases. To get at the real meaning of savage life, and to be able to properly interpret the beliefs of the savage, would imply in many cases long residence among these people. Perhaps too often, during the past, a hasty explanation has been given of what was thought to be understood. The savage does not clearly understand the reasons and causes for his own beliefs, his language is inadequate to give an accurate explanation. Educated people find it difficult to tell what they mean by soul; the savage no doubt experiences greater difficulty. He may not be able to think in abstract terms, or to conceive of an abstraction separate from an object. The psychology of the savage mind has not been sufficiently studied. He has no need for the shades of meaning expressed by various words in modern psychology. While the data given may not all be correct—much of it is, and as such is valuable as a basis for our study.

The first point that demands our attention is the state of mind of the savage. What conditions have given rise to any idea of the soul? Again, what are some of the explanations that have been offered to account for any idea of a soul, or how has the idea arisen?

As to the state of mind of the savage Lang offers the following:

---

[1] The principal data on the beliefs of primitive people are found in the following named works:

Primitive Culture, Tylor; Golden Bough, Fraser; Psychologie der Naturvölker, Robinsohn; International Archiv für Ethnologie, Vol. XIII, 1900; Journal of American Folklore; Myths of the New World, Brinton; Native Races, Bancroft; Teutonic Myths, Grimm, Vol. IV; Popular Science Monthly, Vol. XXXIV; Sociology, Vol. I, Spencer; Descriptive Sociology, 8 parts, Spencer: Zeitschrift für Ethnologie, L'Anthropologie; Psyche, Rhode American Anthropologist, International Archiv für Ethnographie, Supplement 1900, Bureau of Ethnology.

"We[1] set out to discover a stage of human intellectual development which would necessarily produce the essential elements of myth. We think we have found that stage in the condition of savagery. . . . . .

"For the purposes of this inquiry, it is enough to select a few peculiarities of savage thought.

1. "First we have that nebulous and confused frame of mind to which all things, animate or inanimate, human, animal, vegetable, or inorganic, seem on the same level of life, passion or reason. The savage draws no hard and fast line between himself and the things in the world. . . . . .

2. "The second point to note in savage opinion is the belief in magic and sorcery. The world and all the things in it, being vaguely conceived of as sensible and rational, obey the commands of certain members of the tribe, chiefs, jugglers, conjurors, or what you will. . . . . .

3. "Another peculiarity of savage belief naturally connects itself with that which has just been described. The savage has very strong ideas about the persistent existence of the souls of the dead. They retain much of their own nature, but are often more malignant after death than they had been during life. They are frequently at the beck and call of the conjuror, whom they aid with their advice and with their magical power. By virtue of the close connection already spoken of between man and the animals, the souls of the dead are not rarely supposed to migrate into the bodies of the beasts, or to revert to the condition of that species of creatures with which each tribe supposes itself to be related by ties of kinship. With the usual inconsistency of mythical belief, the souls of the dead are spoken of, at other times, as if they inhabited a spiritual world, usually a gloomy place, which mortal man may visit, but whence no one can escape who has tasted of the food of ghosts.

4. "In connection with spirits a far-reaching savage philosophy prevails. It is not unusual to assign a ghost to all objects, animate or inanimate, and the spirit or strength of a man is frequently regarded as something separable, or something with a definite locality in the body. A man's strength and spirit may reside in his kidney fat, in his heart, in a lock of his hair, or may even be stored by him in some receptacle. Very frequently a man is held capable of detaching his soul from his body, and letting it roam about on business, sometimes in the form of a bird or other animal.

5 6. ". . . . The savage, like the civilized man, is curious. The first faint impulses of the scientific impulses are at work in his brain; he is anxious to give himself an account of the

[1] A. Lang: Mythology, Ritual and Religion, Vol. I, pp. 48-51.

world in which he finds himself. But he is not more curious than he is, on occasion, credulous. His intellect is eager to ask questions, as is the habit of children, but his intellect is also lazy, and he is content with the first answer that comes to hand."

These are some of the conditions with which the intellect of the savage deals. He no doubt seeks the easiest means of explanation, and is satisfied for the time being.

Fraser[1] offers the following explanation:

"As the savage explains the processes of inanimate nature by supposing that they are produced by living beings working in or behind the phenomena, so he explains the phenomena of life itself. If an animal lives and moves it can only be, he thinks, because there is a little animal inside which moves it. If a man lives and moves, it can only be because he has a little man inside who moves him. The animal inside the animal, the man inside the man, is the soul." The activity of a man or animal is explained by the presence of the soul, sleep or death by its absence. Sleep and trance is the temporary, death the permanent absence of the soul.

Tylor[2] says the personal soul or spirit among lower races may be defined as follows: "It is a thin, unsubstantial human image, in its nature a sort of vapor, film or shadow; the cause of life and thought in the individual it animates; independently possessing the personal consciousness and volition of its corporeal owner, past or present; capable of leaving the body far behind, to flash swiftly from place to place, mostly impalpable and invisible, yet also manifesting physical power, and especially appearing to men waking or asleep as a phantasm separate from the body of which it bears the likeness; continuing to exist and appear to men after the death of that body; able to enter into, possess, and act in the bodies of other men, of animals, and even of things." This definition has wide application, is, in fact, a general definition, yet as one having universal significance it was not so claimed by the author.

This conception of the soul "preceded and led up to the more transcendental theory of the immaterial and immortal soul, which forms part of the theology of higher nations."[3]

Bancroft[4] speaking of the native races of America says: "The most general idea of a soul seems to have been that of a double self, possessing all the essence and attributes of the individual, except the carnal embodiment, and independent of the body in so far as it was able to leave it and revel in other

[1] Fraser: The Golden Bough, Vol. I, p. 121.
[2] Tylor: Primitive Culture, Vol. I, p. 429.
[3] Tylor: *op. cit.*, Vol. II, p. 24.
[4] Bancroft: Native Races, Vol. III, p. 514.

scenes or spheres. It would accordingly appear to another person, by day or night, as a phantom, with recognizable form and features, and leave the impression of its visit in ideas, remembrances, or dreams."

But how dim or obscure this idea may be. Let us take for example the belief of the Ashantis. According to Müller [1] this tribe has a word *kla*, which means the life of man. If used as a masculine, it stands for the voice that tempts man to evil. If used in the feminine, it is the voice that persuades us to keep aloof from evil. Lastly, *kla* is a tutelary genius of a person who can be brought near by witchcraft, and expects sacrifices for the protection which he grants. When a man dies, his *kla* becomes *sisa*, and a *sisa* may be born again."

Or if we take another example, what do the Indians believe with regard to the soul?

An account of the Omaha Indian belief is given by Mr. La Flesche. He says there are a variety of beliefs concerning the immediate action of the spirit upon its withdrawal from the body. "Some think that the soul at once starts upon its journey to the spiritland; others, that it hovers about the grave as if reluctant to depart. Because of this latter belief, food and water are placed at the head of the grave for several days after the burial. The spirit is supposed to partake of this food. No Indian would touch any article of food thus exposed; if he did the ghost would snatch away the food and paralyze the mouth of the thief, and twist his face out of shape for the rest of his life; or else, he would be pursued by the ghost, and food would lose its taste, and hunger ever after haunt the offender." [2]

The concept of immateriality, lacking content is as incomprehensible for the savage, says Schultz,[3] as for the subtle metaphysician, who forms the immaterial concept but cannot demonstrate it. Because the human soul or spirit, as a picture, is not bound up in space and time. At death, it leaves the body quickly and is not seen; in the dream it is supposed to travel great distances with very great rapidity. These ideas early led to the conception, thinks Robinsohn, that the soul was fleeting, light, and movable in its nature, and that it had the form of an animal.

In the separate treatment of ghosts and spirits, especially in their connection with primitive man's ideas of the soul, no sharp lines can be drawn. It is, as Hartland says,—speaking of the lower stages of civilization, "No distinction is drawn between supernatural and spiritual beings who have never

[1] Max Müller: Origin of Religion, p. 112.
[2] La Flesche: Journal of Folklore, Vol. for 1889, p. 11.
[3] Kosmos, III. Jahrg., 6 Bd. S. 327 (Robinsohn, *loc. cit.*, p. 37 quoted), *ibid.* p. 37.

been enclosed in human bodies, and the spirits of the dead. Savage philosophy mingles them together in one phantasmagoria of grotesquery and horror. The line which separates fairies and ogres from the souls of men has gradually grown up through ages of Christian teaching; and broad as it may seem to us, it is occasionally hardly visible in these stories."[1]

Robinsohn in his Psychologie der Naturvölker,[2] thinks that the sight of the dead has influenced savage belief.

As the naïve savage mind viewed his dead relative, who a short time before spoke and moved freely, he must, involuntarily, have come to the conclusion that something had left the body; and that something we call the soul. Thus the significance of death was explained and the soul discovered. But in arriving at the idea of soul, first he considered the dream as a real occurrence, and then from the facts of the dream, he concluded that he is a double being, a synthesis of body and that part of him that made journeys and gained new experiences while he slept. The soul is[3] assumed, among many peoples, to have animal form. This notion has probably grown out of the fact that during the dream period the soul is supposed to travel over great distances in a moment's time. The savage hunter knows that many animals and especially birds have this swiftness of movement, so by analogy he concludes that the soul must have a like means of travel. Of the different forms which are sometimes ascribed to the soul, the human form is the one most often given. The savage is led to this conclusion, Robinsohn thinks, partly by the effect of the dream, but more impressively by the shadow itself. Why he fixes upon the shadow is because it has the contour of the body, is intangible, and disappears on the approach of darkness. The fact that there are some peoples, as the Abipone Indians for instance, who do not comprehend the meaning of death,—that is, that it is the end of corporeal existence—but do know of dreams, has led Mr. Robinsohn to lay great stress on the dream as being the true inlet of the belief in a soul. Bordeaux[4] bases very much on the dream. He points out the influence of the dream on our philosophical system, contending that metaphysics and the entire transcendental world has been built up on the basis of the belief in dreams. The resemblance of death to sleep, not easily distinguishable even by civilized peoples at times; the dream as a reality, a part of the body independent at times; these form a substantial basis of belief in an unseen image of the individual, or soul, for the savage. They form a basis for

[1] Hartland: The Science of Fairy Tales, p. 43.
[2] Psychologie der Naturvölker, p. 2.
[3] *Ibid.*, p. 7.
[4] Problème de la Mort.

another world, that of spirit and thought, which civilized man has tried so often to describe and explain.

Spencer[1] thinks that "dream-experiences necessarily precede the conception of a mental self; and are the experiences out of which the conception of a mental self eventually grows."

These ideas, as expressed by different students of the subject, while they are not stated as scientific facts, are merely satisfactory or plausible explanations.

The dream is the most influential factor, because the experiences of dream life seem real, and to the savage may seem an actual experience. Then the shadow had contributed an idea of form, the breath some idea of color or tangibility. But underlying all these—the one mystery that has given vitality and served to perpetuate these ideas is that of death.

The Word "Soul."

Let us turn to the word "soul" and study its meaning as expressed by various peoples. An analogous comparison is usually made of what the savage regards as the soul with the function of some organ of the body. The shade of meaning expressed depends on the organ or function with which it is compared.

The data, however, is valuable in getting at the actual facts of belief.

Some words used for "soul" by various tribes, and their synonymous meanings are as follows:

Iroquois. Eri or eriasá, or aweriasá—the soul; the heart; and the mind, considered as the seat of sentiment.

Mohawk. Atouritz—Soul; atourion—to breathe (derived from same root).

Algonquin. Tchuk, or Otachuk—Soul, shadow.

Abipones. Loàkal—Shadow, soul, echo, picture.

Aztec. Ehekatl—wind, shadow, soul.

Zulu (Negro). Isi-tunzi—soul, shadow.

Bechuana (Negro). Isi-tuuzi—soul, shadow.

Papuan. Geist (not aboriginal with them)—soul, steam, fog.

West Australian. Wang—breath, spirit, soul.

Negroes of West Coast Africa. The soul usually called "kra," is a guardian spirit that lives in the man. The immortal part is the man himself in a shadowy or ghostly form, called *srahman* (Sunsum—Spirit and shadow).

Java. Ñava—breath, life, soul.

Tasmanian. Warrawah—shade, shadow, ghost or apparition.

Karens. Lá—soul, ghost or genius.

Carib. Iouanni—soul, life, heart.

Old Calabar. Ukpon—soul, shadow.

Basutos (Negro). Seriti—shadow, or spirit remaining after death.

Arawak (Indians). Ueja—shadow, soul, or image.

Quiché (Indians). Natub—shadow, soul.

Netela (Language of Cal.) Piuts—life, breath, soul.

---

[1] Sociology, Vol. I, p. 157.

Basque. Arima—Soul, astoarin arima—butterfly.
Eskimo. Silla—air, wind, world, mind.
Gypsies. Dūk—breath, spirit, ghost.
Arabic. Ruh—breath, spirit.
Sanscrit. Atman—Soul, spirit, breath, sun, fire.
Gothic. Saivala—Soul, the word related to *saivs* which means the sea, from the root *si* or *siv*—to shake. The soul is conceived by the Teutons as a sea within, heaving up and down.
Hebrew. Nephesh—breath, life, soul, mind, animal; Ruach and Neshamah—breath, spirit.
Greek. Thymos—soul, from *thyein*—to rush, or move violently.
Romans. Latin (Cicero). Animus—mind, from *anima*—air, soul. (From the latter word we have animal.) *Anima* comes from root *an*—to blow. In Sanscrit, anila—wind; in Greek, anemos—wind.

European Words for Soul.

Old High German—Sêola.	Slavonian—Duzha.
Middle High German—Sêle.	Bohemian—Duse.
New High German—Seele.	Polish—Dusza.
Anglo-Saxon—Sáwl.	Lithuanian—Duszia.
Old Norse—Sâl	Litt—Dwehsele.
	(Psuche).
Swedish—Själ.	Greek—(ψυχή)
Danish—Själ.	Latin—Anima.
Finn—Sielu.	Italian—Anima.
Russian—Dusha.	French—âme.
Servian—Dusha.	Old French—arme.

Spanish—Alma.

These words are all feminine gender, and, as Grimm[1] points out, distinguish this conception of the soul from the masculine breath and spirit.

In the German language we have the terms "geist" and "seele" for which the following explanation has been given.[2]

The words "*geist*" and "*seele*" (spirit and soul) are among those; the derivation of which is not yet satisfactorily ascertained.

"In the word '*geist*,' it does not assist us much to refer to the older forms accessible to us. The Gothic does not possess the word, at least so far as our sources reach; rather the Gothic translates the Greek '*pneuma*' by '*ahma*.' The Anglo-Saxon has the word in the form of 'gast;' in the old Saxon it appears as 'gest;' and even in the old High German it reaches far back in the forms '*geist*' and '*keist*.' On the other hand, again, it is wanting in the old northern, which reproduces the idea of 'pneuma,' '*spiritus*, in the word 'andi' (masc). But even this '*andi*' does not occur in the rythmical Edda, and seems generally only to be used in prose, and in such poems as bear a distinctly Christian character. All the forms in

[1] Teutonic Myth, Vol. II, p. 826.
[2] R. von Raumer, on *Geist* and *Seele*, "referred to the fundamental idea of their Germanic appellations," in Delitzsch, "System of Biblical Psychology," trans. 1890, Edinburgh.

which the older Germanic languages present the word *'geist,'* testify (1) that the initial sound is a mute in the Gothic degree of sound *'g;'* (2) that the vowel of the word (High German *'ei,'* Anglo-Saxon *'a,'* old Saxon *'e'*) correspond to the Gothic *'ai.'* Hence it follows that the derivation of the word 'Geist' from the old High German *'jesan'* (*fermentescere*, to ferment) is untenable. Grimm (*Gramm.* ii. 46) traces *'geist'* back to the root *'geisan,' 'gais,' 'gisun'* (*ferire*), but this root itself is only assumed to exist. There remains, therefore, nothing to do but to bring together the words of the Germanic languages whose sound accords with *'geist,'* and whose import points to a connection with this word. In a peculiar manner the two old Germanic languages from which the word *'geist'* proceeds, actually present some words which probably lead us to the fundamental idea of the word. The old-northern has a trace of a word *'geisa'*—*cum impetu ferri, cito cursu ferri, ruere.* But the Gothic renders ἐξίσταμαι Mark iii, 21 by *usgaijan;* Luke ii, 47, and elsewhere ἐξιστάσθαι by *'usgaisnan.'* We should thus be led to suppose that the idea lying at the root of the word *'geist'* is that of quick, hasty movement. The old-northern substantive *ódr* (Völuspa 18), spirit, offers an analogy with this ideal affinity in its reference to the adjective *ódr*, rash, impetuous, fierce, and to its root, *vada praet: od*, to go along eagerly, with force.

"The word *'seele'* (soul), Gothic *'saivala,'* seems to be connected with the Gothic *'saivs'* (late High German, *'See'*); and the connecting idea appears, in like manner, to be that of movement, although of a gentler kind. The word *'seele'* occurs in the Gothic (*'saivala'*) old High German (*'sêla'*), Anglo-Saxon (*'sâvul'*), *'sâvl,' 'saul'*), old Saxon (*'sêola,' 'siola'*). On the other hand, the word does not seem to have appeared in the old-northern until the period of Christianity. In the whole rhythmic Edda, only the distinctly Christian *'Solarliod'* contain it. We have the original psychological mode of expression of the north German in *'Völuspa'* 18, where *ódr* is interchangeable with *'geist,'* and *ond* with *seele*, without, however, implying that by these ideas are hidden there in all their meaning and extent. At all events, it looks as if Christianity had been the first means of representing the *ódr* of the Edda as *'andi,'* the *'önd'* of the Edda as *'sâl.'* The Icelandic translation of the New Testament (Kaupmannahaufn, 1807) renders 'pneuma, by *'ande,'* psuché' by *'sal.'* There needs still further investigation to tell us how far, in the other Germanic languages also, the promulgation of the words *'geist'* and *'sêle'* might be associated with the introduction of Christianity."

The Influence of Dreams.

Some writers, as above noted, think that the dream alone has given rise to our idea of the soul. Civilized man has passed far beyond this state of mind. The educated person rarely connects the dream with his idea of soul, or is it associated with his religion. But how is it with the child? And what has it meant for the savage?

Spencer[1] notes that "hunger and repletion, both very common with the primitive man, excite dreams of great vividness. Now, after a bootless chase and a long fast, he lies exhausted; and, while slumbering, goes through a successful hunt,—kills, skins and cooks his prey; and suddenly wakens when about to take the first morsel. To suppose him saying to himself, 'It was a dream,' is to suppose him already in possession of that hypothesis which we see he cannot have. He takes the facts as they occur." That is, as he further states, another part, his other self has experienced these things, while his body has remained at rest. This is without doubt a correct interpretation, and such an experience would greatly influence the savage.

"He knows nothing[2] of sensations and ideas—has no words for them. Still less has he any such highly abstract word or conception as consciousness. He does not think about thought; neither do his faculties suffice for this. During early stages he merely thinks without observing what he thinks; and therefore never asks how he thinks, and what it is which thinks. His senses make him conversant only with things externally existing, and with his own body." Mr. Spencer thinks that the savage thus takes the dream psychoses as they occur, as facts, and for no other reason than that he lives and acts in the external world, that of sensation, and has no concept of mind or dream. He cites examples of the poverty of aboriginal languages as a further proof that psychoses are all alike considered real. Since the savage considers the dream as an actual experience, then the idea of a dual existence, *i. e.*, of being in two places at the same time is inevitable.

The Indians of South America in order to produce the state of the dream, which is considered by them a reality and during which many wonderful achievements are executed, use poison as a narcotic. Among the Schingu Indians as Schmeltz[3] relates, the medicine-men kill themselves with the poisonous drug in order, as they think, to change the human form into

---

[1] Spencer: Prin. of Sociology, p. 148.
[2] Spencer: Sociology, Vol. I, p. 146.
[3] International Archiv für Ethnologie, Vol. XIII. Beliefs of the South Amer. Indians.

that of the shadow or soul without the body. This use of the narcotic is one of the devices which the medicine-man employs against the superstitions of his tribe. Death itself, says Schmeltz,[1] is regarded as a narcotic effect of some kind in the body, causing the shadow to be separated from it, never to return to awaken the sleeper.

The idea of the soul as related especially to the dream among different tribes is as follows:

Schingu Ind. (S. Amer.). They believe that experience in dreams is reality, and that while the body is in the hammock they are still able during the dream to hunt, fish and fell trees.

Iroquois. The rational soul was believed to visit the objects thought of in the dream, while the bodily soul remained.

Negroes of West Coast Africa. Dreams are regarded as the adventures of the "Kra." Sickness occurs only during its absence.

Bakairi (S. Amer.). The shadow is believed to wander about during sleep. It is dangerous to waken a person during its absence and its search to return to the body causes headache at night.

Paressi (S. Amer.). Have an idea regarding the soul similar to the above mentioned belief. The soul, or shadow, is called "Niako." It leaves the body at the neck and a ringing in the ears denotes its return.

Bororó (S. Amer.). Believe the dream to be a reality and try to induce it as a means of communication. The soul, "bupe," leaves the body of the sleeper in the form of a bird. It experiences many things on its journey and what it relates is regarded as the absolute basis of truth.

Karaya (S. Amer.). The spirit is thought to leave the sleeping body in order to ramble about and hold intercourse with other persons or spirits.

New Zealander. During sleep the mind or soul is believed to leave the body to hold converse with friends. The facts and adventures of dream are the objects seen during its wanderings.

Tagals (Luzon). The soul leaves the body during sleep. It is considered dangerous to waken a person during its absence.

Greenlander. Certain of these people believe that the soul quits the body during sleep, and goes hunting, visiting, etc.

Fiji. The spirit of a living man is said to leave the body in order to trouble other persons when asleep.

Dyaks (Borneo). The dream represents the actual experiences of the soul which is supposed to go on expeditions of its own during sleep. It is said to see, hear, and talk in its meanderings.

Karens (India). During sleep the lá, or spirit, is believed to wander to the ends of the earth; our dreams consist of the things the soul, or lá, sees and experiences on its journey.

Peruvian. Believe that the soul leaves the body while it is sleeping, and what we dream are things seen in its wanderings. The soul cannot sleep.

Japanese. [2] If a sleeper is awakened suddenly and violently, he is sure to die, because his soul is rambling The soul is supposed to have form and color, and to be a small, round, black body. Its adventures furnish material for imaginative literature.

Chinese.[3] The soul is thought to travel during sleep. The spiritual

[1] Int. Arch. für Eth. Vol. XIII. Beliefs of the South Amer. Ind., p. 5, *ibid.* 6.

[2] and [3] Oakes: Popular Science Monthly, Vol. XXXIV.

man, or soul, of Tih Kwalee, one of the gentry, was on a voyage, so the story goes, and a wild beast ate the body during its absence. On its return the spirit, finding only the skeleton of the man, entered the corpse of a black lame beggar near by and always afterwards walked with a staff.

Burmese. It is believed that the Leip-bya (butterfly spirit), wanders during sleep. Its encounters are considered to be the explanation of dreams. Sickness is thought to be due to some misfortune befalling it on one of these excursions.

Celts. The old belief is that the soul wanders from the body at times. It is related of two young men that while sitting on the bank of a cascade, one of them fell asleep; the other, seeing issue from his mouth an indistinct form no larger than a humble-bee, tried to waken him, but before he succeeded the cloud-like creature returned, and the young man awoke and related a wonderful dream.

Buriat. The soul is believed to quit the body during sleep. It visits the spirits and remembers its experiences.

Vedanta (philosophy). In deep sleep the soul separates itself from the body and remains with God or the world-soul during the slumber.

A different idea, emphasizing another side of dream life, is brought out by the savage when he proclaims that he has been visited during the dream by some one in spirit. In addition to the idea that the soul departs during sleep the Indians held this conception of the dream. They believed that the personages met in the dream were real and must be obeyed.

Sandwich Islanders. Departed members of the family sometimes appear in a dream to the survivors, and watch over their resting.

Malagasy. The good demon comes to tell them in their dreams when they ought to do a thing, and to warn them of some dream.

Africa, Congo People. Think that the things they see and hear in dreams come to them from spirits.

Wanika (E. Africa). Believe that the spirits of the dead appear to the living in dreams.

Kaffirs. Ascribe dreams in general to spirits.

Zulu. Two views are held: (1) The individual may be visited in a dream by the shade of an ancestor, the itongo, to warn him of danger; (2) he may be taken by the itongo to visit distant scenes.

Indians. Two ideas prevail: (1) Either a soul from without visits the sleeper; (2) or, the rational soul goes on an excursion during sleep, while the sensitive soul remains with the body.

Fijian. The spirit of another person is believed to come to visit him during sleep.

Indian of Brit. Columbia. Believes that the spirit of another comes to visit him in a dream.

Negroes of South Guinea. Dreams are thought to be the visits of the spirits of deceased friends.

Ancient Greeks. Believed that the dream-soul is a visitor from the dead. Achilles was visited by the soul of Patroclus. Homer LXXIII, 59.

Romans (Cicero). Dreams are both phantoms of the living and ghosts of the dead. De Divinatione I, 27.

The Soul as an Animate Form.

The most common attribute of the soul, if we may so speak of it, is that of animate form; the soul being represented as some animal. As will be seen in the list of animals noted be-

low, the serpent and bird are frequently used, and again the butterfly. In regard to the bird, Brinton[1] suggests that "it has the incomprehensible power of flight; it floats in the atmosphere, it rides on the winds, it soars toward heaven where dwell the gods; its plumage is stained with the hues of the rainbow and the sunset; its song was man's first hint of music; it spurns the clods that impede his footsteps, and flies proudly over the mountains and moors where he toils wearily along. He sees no more enviable creature; he conceives the gods and angels must also have wings; and pleases himself with the fancy that he, too, some day will shake off this coil of clay, and rise on pinions to the heavenly mansions. All living beings, say the Eskimos, have the faculty of soul, but especially the birds."

Since to the Indian, says Schmeltz,[2] incorporeality of soul is not to be comprehended, and because the spirit of the dead appears in human form, that is, as shadow, he always identifies body and spirit and ascribes to spirits or ghosts of deceased persons the same activities, needs and cares that belong to the living.

Birds.

Because of some fanciful resemblances, perhaps, as suggested by Brinton, many tribes have associated the soul with birds.

Icannas (Ind. S. A.). The souls of the brave were believed to travel in beautiful birds and to eat luscious fruit, while those of cowards became reptiles.

Kailta (Ind. Cal.). When a person dies a little bird is thought to fly away with his soul to the spirit-land. If he was a bad Indian, a hawk catches the little bird and devours it, feathers and soul.

Bororo (S. A. Ind.). During a dream the soul is thought to travel in the shape of some bird, and at death to be changed into a red Arara.

Makusi (S. A. Ind.). The cry of a nocturnal bird, the goat-sucker, is believed to be that of a spirit in the form of a bird.

Powhatan (Ind.). A certain little woodbird was supposed to be the soul of the dead chieftains of this tribe. Great care was taken not to harm this bird.

Hurons (Ind.). After the burial of the bones at the feast of the dead, the soul is thought to pass into the form of a turtle-dove. This is also the belief of the Iroquois Indians.

Caribs (Ind.). The bat is thought to be a departed spirit.

Algonquin (Ind.). There is thought to be two souls; the animate soul, which departs from the corpse in the shape of a dove, and the physical, which enters into another human being.

Finns. The Milky Way was called the Birds' Way, or the way of souls. The Lithuanians, and nearly all Indo-European peoples, had similar sayings.

---

[1] Myths of the New World, p. 123.

[2] Beliefs of the South Amer. Indians. Inter. Arch. für Eth., Vol. XIII, p. 10.

Bohemians. The heathen Bohemians thought that the souls of the dying flew out of their mouths in the shape of birds.
Celebes. The soul is conceived of as having the form of some bird. It is thought that the bridegroom's soul is liable to fly away at marriage, so colored rice is scattered over him to induce it to stay.
Servians The soul is represented as an aerial or bird-shaped substance, which escapes from the body at death and, like a timid bird, flits from tree to tree until the burial. It is often transformed into a cuckoo.
China. After twenty-one days of mourning for the dead, paper storks are placed on poles in front of the house that they may carry the soul of the departed one to paradise.
Egyptians. One part of the soul, the "ba," was represented as a bird with human head and hands.
Moslems. The souls of the faithful are believed to assume the form of snow-white birds and to nestle under the throne of Allah between death and the resurrection.
Saxons. Many Saxons represent the soul as a dove which ascends to heaven, or as a humming-bird which goes to heaven after twenty-four hours.
Romans. The myth of Aristeas, as related by Pliny,[1] represents the soul of the dying man as issuing from his mouth in the form of a raven.
Latin. When a ship founders, those on shore are said to observe the souls of the drowned to fly upward as white doves.
[2] It is a graceful fancy which makes the departing soul either break into a blossom as a flower, or fly upward as a bird.

After Sankara[3] had destroyed the Buddhists in India to prove his supernatural powers to the Grand Lama, he soared into the air, but the Grand Lama perceiving his shadow, as he mounted up, struck his knife into it and down fell the Sankara and broke his neck.

Schmeltz[4] thinks that in accounting for the fact that the soul is supposed to take the form of a bird, or to pass into one, there is to be considered, besides the idea of rapid flight, the lamenting cries of some birds in the night time. These strike terror to the savage and lead him to imagine an imprisoned soul that longs to be back with its friends.

Butterfly.

Nicaraguan (Ind.). The soul of the man, called "Yulio," is believed to separate itself at death and become a wavy, flying substance. It issues from the mouth and looks somewhat like the person.
Karens. The soul is conceived of in the form of a butterfly.
Servians. [5] Believe that the soul of a sleeping witch often leaves her body in the form of a butterfly. If, while it is absent, her body is turned around and her feet placed where her head was before, the soul will not find its way back into the body and the woman will die.

---

[1] Pliny: Nat. Hist., VII, Sec. 174.
[2] Grimm: Teutonic Myth., Vol. II, p. 826.
[3] Frazer: *op. cit.*, Vol. I, p. 142.
[4] Beliefs of the South Amer. Ind., Inter. Archiv für Ethnog., Vol. XIII, p. 14..
[5] Frazer: I, 127.

Burmese. The immortal soul is called Leip-bya, meaning butterfly or spirit.

[1]Among the Burmese, when the mother dies leaving a young baby, it is thought that the "buttterfly," or soul of the baby follows that of the mother and if it is not recovered, the child will die. A wise woman is called to bring back the child's soul. She allures it back by means of a mirror held near the corpse. On the mirror is placed a piece of feathery cotton-down. She then entreats the mother not to take the soul of the child with her, meanwhile catching up the down with a cloth and placing it on the baby's breast.

Irish. The uneducated peasantry regard the pure white butterfly to be the soul of the sinless and forgiven dead on the way to paradise; the spotted ones, condemned souls on the way to purgatory, the spots corresponding to the number of sins.

Italy. A butterfly flitting around a baby's cradle is believed to be either an angel's or a baby's soul.

Russians. When the soul escapes from the body, according to folk-tales, it is sometimes represented as a little bird, or butterfly, and sometimes as a minature human form.

Christianity. Angels are represented as having wings. Psyche is shown as a butterfly on the open hand, or at least, with wings.

Mouse, etc.

Mohaves (Ind.). The soul is believed to rise as the smoke of the funeral pyre curls upward. If the soul is impure from crime or stained with human blood, it is transformed into a rat and must remain four days in a rat-hole to be purified.

Swabian belief. A story relates that a girl's soul creeps out of her mouth in the form of a white mouse.

German (legends and myths). The mouse is symbolic of the soul. A little red mouse is sometimes said to issue from the mouth of the sleeper as the departing soul or spirit.

Russians. The peasants often speak of the Milky Way as the Mouse-path, the mouse being a well-known figure of the soul.

The prevalence of the belief, so common in Eropean folklore, that the mouse represents the soul, has led Mr. Conway[2] to formulate the theory that the shudder which some nervous people feel at the sight of even a harmless mouse, is a survival of the time when it was believed that in this form unshriven souls, or those of unbaptized children, haunted their former homes.

Serpent.

Kaffir. When a Kaffir sees a serpent in his dwelling, he thinks that the soul of some dead person has returned for revenge.

Zulus. The incarnated spirit is called "Ihlozi." If a serpent is seen on the grave, the Ihlozi is believed to have taken up its abode.

Arabs. The serpent is believed to be no ordinary creature, but a "deschim," a spirit. Mohammed recognized good and evil spirits in the serpent.

German (Myth.). The soul was seen to come from the mouth of King Gunthrum in the form of a little serpent.

---

[1] Frazer: I, p. 130.

[2] Demonology and Devil Lore, Vol. I, p. 128.

Lizards.

The Santals[1] believe the soul to have the form of a lizard, and relate how on one occasion it left the body, while the owner was asleep, and entered a pitcher of water to drink. Just then the owner of the pitcher covered it, the soul did not return to the body and the man died. But while they were preparing to burn the body, some one uncovered the pitcher—the soul escaped, returned to the body and the man revived.

Among the Netherlandish peoples, in the stories of King Gunthrum, the soul is depicted as issuing from his mouth in the form of a small reptile.

Fish and other Animals.

Kaffirs. Fish are not eaten because they are believed to embody souls.

East Brazil (Ind.). The soul is thought to pass into the fish that are placed on the grave and it is in this way protected.

Nias. The heart soul (Noso dodo) is believed to survive after death in the form of a spider.

Kaingué (Ind. S. A.). It was thought that a tiger which roamed about in the vicinity of a burial ground was the changed form of a recently buried person.

Buriat. The soul is believed to take the form of a bee.

Goyatacas (Brazil Ind.). This tribe believes in the immortality of the soul. The soul is thought to wander for a time in the body of a cow.

In Transylvania[2] it was reported at the trial of a witch, that the woman, together with two men who were employed by her in a vineyard, lay down at noon to rest. She failed to awake at once. A large fly was seen buzzing around. This was caught by one of the men and put into his leather bag. For some time they were unable to waken the woman. Later, however, the fly being released flew directly into her mouth and she awoke. They then knew that she was a witch.

Frazer[3] relates the incident of a Melanesian woman who, knowing that a neighbor was at the point of death, heard a rustling in her house as of a moth fluttering. The lamentation told her at the same instant that the soul had flown. She caught the fluttering thing, ran with it and held it above the open mouth of the corpse; but it failed to revive.

The natives of the Danger Islands[4] of the South Pacific believe in different sizes of the soul. The sorcerers set snares of different sizes of stout sennit, fifteen to thirty feet long, with loops on either side to suit the size of the different souls. For fat souls there are large loops, for thin souls small ones. This

[1] Frazer: I, 126.
[2] Frazer: Vol. I, p. 126.
[3] The Golden Bough, Vol. I, p. 136.
[4] Gill: Myths and Songs of the South Pacific, p. 171

method was employed by the sorcerers against persons towards whom they bore ill-will, and accordingly when a man was sick these soul-snares were set up in the trees near his house. The soul might be caught in the shape of a bird or insect, and if so, the man infallibly died.

These various associations of the soul with different forms of animal life, as expressed above, from one standpoint suggest something of the pathetic. Realizing that, physically, they cannot accomplish, or reach a certain ideal they have in mind, the savage imagines, with child-like simplicity, that the fulfillment of these ideals will be attained by means of increased powers. He could satisfy many of his longings if he were only able to accomplish certain things that animals can do so easily.

The Shadow.

What has been the influence of the shadow on the minds of primitive peoples? Has it contributed to the idea of the soul? We cannot but think it has influenced their idea of form. Many primitive peoples say that the soul is a shadow. What do they mean? Max Müller[1] says:

"I do not in the least believe they think the shadow a soul, or the soul a shadow; but they use the word shadow figuratively for that belonging to man, which is like his shadow, definitely individual, and inseparable from him, but unsubstantial. The Mota word we use for soul is in Maori a shadow, but no Mota man knows that it ever means that. In fact, my belief is, that in the original language this word did not definitely mean either soul or shadow, but had a meaning one can conceive but not express, which has come out in one language as meaning shadow, and in the other as meaning something like soul, *i. e.*, second self."

"What we must try to understand is exactly this transition of meaning, how from the observation of the shadow which stays with us by day and seems to leave us by night, the idea of a second self arose; how that idea was united with another, namely that of breath, which stays with us during life, and seems to leave us at the moment of death; and how out of these two ideas the concept of a something, separate from the body and yet endowed with life, was slowly elaborated. Here we can watch a real transition from the visible to the invisible, from the material to the immaterial; but instead of saying that people in that primitive stage of thought, believe their souls to be shadows, all we should be justified in saying would be that they believed that, after death, their breath, having left the body, would reside in something like the shadow that follows

[1] Max Müller: Origin of Religion, p. 86.

them during life. The superstition that a dead body casts no shadow, follows very naturally from this."

The shadow has a certain form, or outline, and is intangible; when the savage says that his soul is a shadow it may be only a comparison.

It is the constant attendant of man during sunshine and pictures him in outline. Brinton notes,[1] "it is of a nature akin to darkness, earth and night."

Schmeltz states that, when the South American Indian wishes to represent the spirit of the deceased, he always gives it the human form. He also calls attention to the part memory plays in this case,—that is, that all phenomena are memory pictures.

If the shadow was not equivalent to the soul, it was, as Frazer[2] thinks, at least regarded as a living part of the man, so that injury done to the shadow was felt by the person or animal just as if it had been done to the body. Ideas expressed among different tribes are as follows:

Zulu (Negro). The soul is thought to be a shadow, having the shape of the body.

Bechuana (Negro). The soul is conceived of as a shadow with human form.

Benin (Negro). They regard their shadows as their souls.

African (other Negro Tribes). It is believed that a man's shadow or shade is intimately connected with his soul, the departed soul of a person being called his shadow or shade. The world of shades is in the region below.

Ojibways. It is described by these people how one of their chiefs died, and while they were watching the body on the third night, his shadow came back into it. The man sat up and then told them how he had travelled to the river of death but had been sent back to his people.

Arawak (Ind.). The word "ueja" equals shadow, soul, picture.

Abipones (Ind.). Loákal equals shadow, soul, echo, picture.

Mohave (Ind.). The soul is called shadow. "When a Mojave dies he goes to another country just like his own; it is the shadow of his own country, the shadows of its rivers, mountains, valleys, and springs, in which his own shadow is to stay."

[3]The demons of the Barbar Islands get power over a man's soul by holding fast his shadow or by striking or wounding it.

The Magicians of the Islands of Wetar, of the South Pacific, can make a man ill by stabbing his shadow with a spike, or cutting it with a sword.

Greeks (Homer). Odysseus recognized many heroes in the underworld as shadows. Among them was his mother; but when he went to embrace her she warned him that she was only a shadow.

Reflection.

While some peoples identify soul with shadow, others believe

---

[1] Myths of the New World, p. 273.
[2] Frazer: The Golden Bough, I, p. 143.
[3] Frazer: I, p. 142.

a man's soul to be in his reflection as seen in water or in a mirror. Frazer[1] has collected considerable data on this conception of the soul.

The Andamanese Islanders think that the reflection seen in a mirror is the soul, while the Fijians believe man to have two souls, a light one and a dark one. The light one is his reflection in water or in a mirror, the dark one his ordinary shadow. The latter goes to Hades. The Zulus will not look into a dark pool because they imagine there is a beast in it that will take away their reflection, causing them to die.

The Basutos of Africa think that crocodiles have the power of killing a man by dragging his reflection under water.

Among the Melanesians, it is believed that if a man looks into a certain pool the malignant spirits get hold of his reflection. If he even glances into it he will die.

According to the ancient Greek idea, to dream of seeing one's self reflected in the water was an omen of death, and Frazer[2] thinks that this is the origin of the story of Narcissus, who, having seen his reflection in the water, pined and died.

Portraits.

The peoples who believe that their soul resides in the shadow or reflection, have a horror of portraits. "For if the portrait," says Frazer[3], "is the soul, or at least a vital part of the person portrayed, whoever possesses the portrait will be able to exercise a fatal influence over the original of it." He mentions some instances of this belief that have been noted. The Canelos Indians of South America think that the soul is carried away in the picture, and it is related that two of them, having been photographed, actually came back the next day to ask if their souls had been taken away. Some of the Wa-teita in Eastern Africa thought they would be entirely at the mercy of the photographer, and the Mandans imagined that they would soon die if their portraits were in the hands of another. Frazer[4] notes that the superstition still exists in various parts of Europe, and it is said that they sometimes pine away and die after being photographed. Some old women of the Greek Islands are thought to have died from this cause, with others perhaps it may prove unlucky, as some of the people in the west of Scotland to-day imagine.

Among the Ainus[5] to speak of the form of a person is equivalent to speaking of his soul, spirit, or ghost. Outlining the

[1] Frazer: The Golden Bough, Vol. I, pp. 145-148.
[2] Vol. I, p. 146.
[3] The Golden Bough, Vol. I, p. 148.
[4] *Ibid.*, p. 149.
[5] Journal of Amer. Folklore, 1894, p. 43.

form on paper was thought to be drawing the soul out and placing it in an unnatural position. It was regarded as a process of transforming a man into a ghost before his time.

Certain Relations of Soul to Body as Expressed Among Some Tribes.

Chinook. The soul resembles fire, and at death sparks are said to fall down. When a person is about to die, the soul is thought to be heavy, but when he is recovering it is light.

Ainu (Japan). The destruction of a body, whatever the form of it may be,—tree, brute, beast or man—is likened to the stripping off of one coat to discover another beneath. The spirit still retains its inner form. Superhuman living forms are thus enshrined in some bodily form.

Chinese. Believe that decapitation makes headless souls in Hades.

Australian. Cuts off the right thumb of the corpse of his enemy so that he cannot throw the ghostly spear with the mutilated hand.

Eskimo. Think that the soul has the same shape as the body to which is belongs, but that it is of a more subtle and ethereal nature. It is pale and soft and cannot be felt.

Tongans. The soul is believed to be the finer, more aeriform part of the body, related to it as the perfume and essence of a flower is to the harder parts.

Caribs. Claim that the soul is visible, but subtle and thin like the purified body.

Romans (Mantanist prophetess) Tertulian De Anima, 9. The soul is thin and lucid, aerial in color, and of human form.

Wuttke (German writer on Ghosts). Ghosts have bodies and a misty, evanescent materiality.

Calmet (Theologian) Vol. I, Ch. xli. Immaterial souls have their own vaporous bodies, bodies provided by supernatural means to appear as spectres; or they may have power to condense the air into bodies.

Forms of Composition.

Wetarese. The soul is likened to the smell of a flower.

Malayans. Believe that the soul escapes through the nostrils.

Siamese. The soul thought to be subtle matter, escaping touch and sight.

Greeks (Epicurus) Diog. Laert., X, 67-8. The soul could neither do nor suffer were it incorporeal.

Romans (Tertullian). The soul is considered material. (1) It is nourished by the body. (2) It cannot be thought of without materiality. (3) A suffering soul must be material. It has human form of an ethereal and light color. It is a clarified, ethereal body.

Hervey Islanders. When the spirit returns from one of its voyages of visit or adventure, some difficulty and excitement is occasioned,—this causes a tingling and enlivening sensation of the body and sneezing.

Bororó (S. Amer.). To sneeze indicates a message from some dead relative,—a spiritual visit.

Similarity to Cloud.

Hervey Islanders. Warrior spirits are thought to constitute the dark clouds of the morning. In cool, cloudy weather the air is thought to be full of spirits. On bright days the spirits take their departure.

Saxony (Seven Cities). When a virtuous man dies, his soul is believed to escape from his mouth as a little white cloud.

Kant died on a nearly cloudless day; only one little white cloud floated in the azure sky. A soldier taking notice of this, remarked, "See,[1] that is the soul of Kant floating toward Heaven."

THE SOUL AS AN OBJECT.

That the soul possesses form or shape is the most generally accepted idea; that it assumes the form of some object is also a common belief. The idea of the soul's being a material object can be only the crudest savage notion, and then it is probable that the object has a symbolic significance.

Beginning with the conceptions of ghost and shadow as material representatives of the soul among primitive peoples, Spencer[2] thinks that from the lowest savage to the highest stages of civilization, a serial classification of beliefs can be made, from the purely material to the immaterial. The classification would correspond with progress in lines of culture and civilization.

Few tribes would compare the soul to a lifeless object, or much less identify it as such an object. We cannot well conceive a state of mind so inferior and inactive; one that could form some notion of soul and yet say that the soul and object are one. We must take it for granted that we do not fully understand what they mean. The first consideration is that the savage is unable to conceive of the soul as separated from a body.

"Body and soul,"[3] "form in the thought of the savage an inner association so closely wrought that he is unable to consider the soul without a body or the body without a soul." As a result of this close connection between the body and the soul in the primitive mind, among some peoples the bodies of the dead, especially of malefactors, are destroyed, in different ways, to prevent the return of the soul. The same writer cites numerous instances of practices, such as placing coins on the eyes and mouth, and others of like character, continued even to-day, superstitious customs that have grown out of the identification of body and soul.

The following identify soul and object.

Fijians. They regard the shooting-stars as gods, and the smaller ones as the departing souls of men.

Lithuanians. Shooting stars are supposed to be the souls of dying men.

Nishinam (Ind. of Cal.). When these Indians see the dust columns

---

[1] Robinsohn: Psychologie der Naturvölker, p. 14.
[2] Sociology, p. 197.
[3] *Op. cit.*, p. 43.

so common in California, they think that some soul is ascending in them to the Happy Western Land.

Algonquins. The story was current among the Algonquins that an old chief having lost his son, journeyed to the land of souls and begged so hard for the soul of his son that the Indian Pluto finally gave it to him in the form and size of a nut.

FORM.

Closely related to the last section we have various notions of form and composition of the soul. Tylor[1] says "My own view is that nothing but dreams and visions could have ever put into men's minds such an idea as that of souls being ethereal images of bodies."

What are some of the ideas of form?

The medicine man of the Flathead Indians[2] is able to restore the lost soul to the sick patient. After a preliminary of cantations in the darkness of the night, he kindles a fire and sorts out the proper soul from the store of those of the dead and living people he has on hand. The soul may have the shape of a bit of bone, splinter of wood, or shell, etc. It is restored to the patient first by placing it on his head,—from thence it is supposed to descend into the body.

Eskimo (Angekoks). Claim that the soul is white and yielding and when one attempts to grasp it, he feels nothing, because it possesses neither flesh, bones or nerves.

Hurons. It was thought that the soul had a head and body, arms and legs; that it was a complete miniature model of man himself.

Nias Islanders (West of Sumatra). The individual chooses the size and the desired length and weight of his soul before he is born. "The heaviest soul ever given out weighs about ten grammes." The length of a man's life is proportioned to the length of his soul.

"The[3] sick man's soul is restored to him in the shape of a firefly, visible only to the sorcerer who catches it in a cloth and places it on the head of a patient."

The Dyak priest of Sarawak conjures the lost soul of the sick man into a cup where it is "seen by the uninitiated as a lock of hair, but by the initiated as a miniature human being." It is then supposed to be thrust by the priest into a hole in the top of the patient's head. Sometimes the soul resembles cotton seeds.

"Amongst the Canadian Indians, when a wizard wished to kill a man he sent out his familiar spirits, who brought him the victim's soul in the shape of a stone or the like. The wizard struck the soul with a sword or an ax till it bled profusely, and as it bled the man to whom it belonged died."

Saxons. The soul is considered to have the same form as the body.

---

[1] Prim. Culture, Vol. I, p. 450.
[2] Wilkes: Narrative U. S. Exploring Expedition, Vol. IV, p. 448.
[3] Frazer: Vol. I, pp. 122-139.

Tennyson. "In Memoriam."

" Eternal form shall still divide
The eternal soul from all beside;
And I shall know him when we meet."

Java (Chinese). The souls of dead relatives who have prospered and have been honored are believed to pass over into their posterity.

Susu. It is believed that the spirit of a dead person may take up its abode in the grandchild.

Ideas of Ghosts.

Visible and tangible expressions of soul.

The word ghost has its origin in the German. The German word geist,—ghost is connected with gust, yeast, gas, and even with the hissing of geysers of Iceland. Teutonic gheist comes from the root word meaning to blow with violence. English ghost and gust are derived from the same word.

The Icelandic word geyser, and likewise the Scandinavian gjösa mean to pour forth.

It is very probable that the idea of ghosts is closely connected with that of the breath. The condensation of moisture borne by the exhaled air may have suggested the color. Some ideas expressed by primitive peoples as to ghosts and spirits are as follows:

Negroes (W. Coast Africa). Srahman, "ghost" or "goblin," also means lightning.

Netela. Word "piuts" mean breath and soul.

Eskimo. Silla—air, or reasoning faculty.

Aztecs. Word "ehecatl" had the meaning of wind, of soul, or life.

Yakama (Oregon Ind.). "Wkrisha" expresses wind, "wkrishwit" means life.

Dakota Ind. "Niya" means breath, literally; figuratively, life.

Negroes (East Coast Africa). Flour is offered to spirits who eat the essence of it. Other tribes, *e. g.*, Galelas and Tobelorese of Hulmahera, Dyaks, and Yorubas, believe that spirits consume the essence of food.

Guiana Ind. Always thinks he sees a spirit in any instrument that does him harm.

Adamanese. Death, sickness, and calamities of any kind are attributed to evil spirits.

New Caledonians. White men are believed to be spirits of the dead and are thought to bring sickness.

Africans (Negroes). When a person dies the air is thought to be unusually full of spirits. Much of the noise of the funeral orgie is to drive them away.

West Africa (Negroes). The soul becomes a ghost, but can be seen only by the wong-man or spirit-doctor.

West Coast of Africa (Negroes). Believe in two kinds of ghosts—those who have met sudden death as in battle or accident, and those dying of old age and from disease. The first linger about their former habitations, clad in white and streaked with clay,—they have not completed their proper term of life. The latter are not seen but pass at once into the land of ghosts.

Central Africa. Some of these tribes have their religious doctrines based on belief in harmful ghosts.

Winnebago (Ind.). Believe in wood spirits. They are described as a rather small animal, with round face and glittering eyes, sometimes seen by man. They are believed to be the cause of disease.

Iroquois. The word "uq-skĕn-nĕ" means a spectre, phantom, the ghost or manes of a dead or living body, death itself. It is applicable only to the sensitive soul, not to the rational.

Turanian Tribes (North Asia). The spirits of the dead Shamans are the ones that plague the living.

Patagonians. Believe that the souls of their wizards become evil demons.

Finns. Ghosts are seen by Shamans only, by others in dreams.

Karens. Believe that a man's spirit disembodied before death may appear to announce his death.

Maons. The sight of an absent person denotes his death.

Peruvians. The soul is thought to rise out of the tomb with all that belongs to the body. It roves about, feeling cold, thirst, hunger and toil.

Hervey Islanders. Believe that the spirits of warriors slain in battle wander for a while among the rocks and trees where the body has been thrown, bearing visible marks of the wounds. They utter sounds like those of crickets.

Karens. The "la" or ghost sometimes appears after death and cannot then be distinguished from the person himself.

Araucanians. Think that the soul, when separated from the body, exercises the same functions in another life as in this, unaccompanied by fatigue and satiety.

Natives of the Antilles. Ghosts are said to appear in the roads, but not to every person.

Australians. Ghosts of the unburied dead are thought to become malignant spirits.

(Aborigines). Believe in an evil spirit called "Metagong" which prowls about at night and catches hold of them if they leave the camp-fire. It is visible occasionally, being of human form and immense size, and of so great strength as to make it useless to offer resistance.

Australians. "The[1] precautions taken by murderers (among the primitive Greeks) to lay the ghost of the slain man were much like those in favor among the *Australians*. The Greek cut off the extremities of his victim, the tips of the hands and feet, and disposed them neatly beneath the arm-pits of the slain man. In the same spirit, and for the same purpose, the Australian black cuts off the thumbs of his dead enemy, that the ghost, too, may be mutilated and prevented from throwing at him with a ghostly spear.

West Africans (Krumen). Europeans are called the ghost tribe. Natives of old Calabar call them spirit-men; Mpongwe call them "ghosts."

Prince of Wales Islands (Darnley Islands Natives). The word used to signify white man, also means ghost.

Chinese. Believe that decapitation makes headless souls in Hades. The souls of beggars and lepers sorely annoy the living.

Israelites. Samuel's ghost was seen by the witch of Endor, but not by Saul.

Greeks. Ghosts are believed to have substantiality, and to drink blood. They recover memory and reason, and recognize their friends,

---

[1] A. Lang: Mythology, Ritual and Religion, Vol. I, p. 259.

but not until they have nourished themselves from the blood of some victim.

(Achilles to Patroclus.) "Alas, there is indeed then, even in the dwellings of Hades, a certain spirit and image, but there is no body in it at all."

St. Anthony saw the soul of St. Ammonius carried to Heaven in the midst of a choir of angels.

Newly baptized children saw the holy bishop, St. Ambrose, in spirit when he died.

Voices of Spirits, Souls or Ghosts.

One of the attributes of the soul, according to primitive belief, is that of voice. The sounds that the spirit or soul is supposed to utter are sometimes heard in the lamentations or hisses of birds, in the moaning of the winds, or in other peculiar noises which may cause even civilized man when alone at night, to experience a shudder.

Chaimas (S. A. Ind.). The cries of the goat-sucker heard in caverns are attributed to the spirits of their ancestors, and nothing can induce these Indians to enter these dark caves.

Makusi (British Guiana). The cries of the goat-sucker at night are believed to be voices of departed souls which are regarded by them as evil spirits.

Abipones (Ind.). These Indians regard the ducks that fly about at night, uttering hissing sounds, to be the souls of departed persons. They believe to hear their shadows speak in the echo.

Tupinambas (Ind.). The prophetic bird is called "Macauhan." It is regarded as the messenger of deceased friends and relatives. The magicians prophesy from the song of this bird.

Algonquin (Ind.). These Indians think they hear the shadow-souls chirp like crickets.

Fuegians. The soul of the deceased person is believed to wander in the woods; an unfamiliar bird's cry is regarded as the cry of a spirit.

New Zealanders. Divine spirits are thought to converse with living persons (spirits) in whistling tones.

Zulus. Ancestral manes are believed to talk in a low whistling tone, this tone is short of a full whistle.

Arabs. Whistling is considered to be talking with devils.

Eskimo. Ghosts and spirits are thought to manifest their presence by a whistling or singing in the ears.

The Number of Souls.

As to the number of souls there is much difference of opinion among different peoples. The idea of a plurality of souls, however, is very common.

Robinsohn[1] thinks that the idea of more than one soul arose from the fact that sometime after the savage had discovered that there was a life-principle,—something lacking at death—he came, gradually, to comprehend the Ego or I. If this be a true interpretation it affords the basis for a belief in two souls.

[1] Psychologie der Naturvölker, p. 33.

There are some tribes, however, who believe in a number of souls—but on the basis, rather, that certain organic functions are regarded as separate souls. Some of the beliefs are as follows:

Malagasy. Believe in three souls: saina, or mind; aina, or life; and matoatoo, or ghost.

Algonquin. Claim that there are two souls, one of which keeps the body animate, remains with it during sleep and after death (until called to enter another body); the other, a physical soul, moves about at will, goes out of the body during dreams or in a trance, and at death goes to the land of spirits.

Dakotas. Most of this tribe believe in four souls. One wanders about the earth and requires food; a second, watches over the body; another hovers around its native village: the fourth goes to the land of spirits.

Iroquois. Believe[1] in two souls, a rational and a bodily soul. Man is thought to have a sensitive soul, which is the animating principle of his body, and one or more reasonable souls, or psychic entities. Of the latter kind, some persons at times are reported to have four or five, at other times, only one or none at all. The animating, or bodily soul, remains in the skeleton at death. The reasonable is represented as subtile and refined, yet material (since it can be enclosed in a gourd); dark and sombre like a shadow, possessing the form of the body, having head, teeth, body, arms, legs, etc., partly blind by day but sharp-sighted at night. It is carnivorous, but eats the food of the living, and can utter sounds and speech.

Hurons. Think that man has two rational souls, both divisible and material. One leaves the body at death and lingers in the cemetery until the feast of the dead; the other is attached to the body.

Sioux. Believe in three souls, one of which goes to a cold place, another to a warm, comfortable country, while the third watches the body.

Chinook (Ind.). Each person is thought to have two souls, a larger and a smaller one. During sickness the smaller one leaves the body.

Choctaw. Every man is believed to have an outside shadow, shilombish, and an inside shadow, shilup, both of which survive the body.

Madagascar (Islanders). Believe that there are three elements of the soul. The feelings, "saina," perish at death; the life, "aina" passes into the air; and the spirit, "matoatoa," hovers about the grave.

Eskimo. Believe in two souls, the breath and the shadow.

Olo-Nagadjoe (Dyak of Borneo). Two souls. These are united in the body under the name, "hambaruan." At death, one of these, the "Lian," is separated from the body,—this is the conscious individuality. The other, "Karahang," is more material and remains with the body.

Nias. Ascribed to man three souls, these were identified with the breath, heart and shadow. The first, "noso," comes from the air and returns to it at death, but passes on to posterity. The shadow, "beahn zi-mate," is seen by day, but by the priests at any time. It becomes a spirit at death. The third, "noso-dado," soul of the heart, is the most complete, being the seat of thought, feeling, joy and anger. It exists after death in the form of a spider.

Fijians. Believe in a dark spirit, or shadow, and a light spirit or reflection.

---

[1] Journal Amer. Folklore, 1895, p. 109.

Natives of Tonga. "All men[1] have not souls capable of a separate existence, only the Egi, or nobles, possess a spiritual part, which goes to Bolotoo, the land of gods and ghosts, after death, and enjoys power similar to that of the original gods, but less."

Greenlanders. Some of these believe in two souls, shadow and breath.

Khonds. Have a fourfold division of the soul. The first soul is restored to or absorbed by the good Deity, Boora; the second is attached to the Khond tribe and is reborn in succeeding generations; the third, goes out in dreams and holds spiritual intercourse; and the fourth dies with the dissolution of the body.

Chinese. Believe in three souls and six spirits. The latter being animal go into the ground at death. Of the three souls, one goes down into Hades, the second enters the coffin and is laid in the grave (but not to remain), the third lingers around its old home, and with the second receives the worship of posterity.

Egyptians. Regard the soul of an individual as being a complex of a number of elements, or spirits. These are immortal. One, the "ka," is similar to the man as he appears in thought or dream; another of these immortal parts, "ab," corresponds to the heart; a third, the "ba," is a material conception of the soul, usually a bird, with human head and hands; a fourth part, the "shâu," is the form of a mummy; a fifth, the "xaib," is the shadow; while a sixth "xu," exists as an appearance or reflection of the mummy. (1) ba—warmth of life, breath; (2) ab—heart; (3) xaib—shadow; (4) ka, sâhu, xu, and Osiris—soul comprehended as copy of the body.

Hindus. Distinguish between Brahmatmah, the breath of God, and Jivatmah, the breath of life.

Hindu philosophy. Emanative Souls and Genetic Souls.

Persians (Zoroaster). Soul consists of five parts. (1) The feroher or principle of sensation; (2) boo or principle of intelligence; (3) the rouh, or rouan, the principle of practical judgment, imagination, volition; (4) the akho, or principle of conscience; (5) and the jan or principle of life. The first three united, are the principles which are accountable for the deeds of man. The jan mingles with the winds, the akho returns to heaven and has a separate existence.

Jews (Rabbis). Taught a three-fold division: (1) Nephesh, the animal; (2) ruah, the human principle of life; and (3) Neshamah, the divine soul.

Greeks (Plato). Make three divisions of the soul:

λογιστικον, επιθυμετικον, θυμος or θυμοειδες,

(Aristotle.) Divided the soul into three parts: (1) the mere nourishing soul (anima vegetativa), or plant soul; (2) the sensing soul (anima sensitiva), or animal soul; (3) the reasonable thinking soul (anima rationalis). All three of these parts are supposed to be united during life. The first two die with the body; the third is immortal.

Greeks (Philosophy of Alexander). Taught that the soul consists of two parts. The (πνευμα) Pneuma, corresponds to the Biblical "Neshamah," which God breathed into man. The (ψυχη) Psuche corresponds to the "Nephesh" whose seat is in the blood.

Romans. Believed in a three-fold division of the soul: the manes, the anima, and the umbra. To each of these a different place was assigned.

Romans (Ovid). The shades flit around the tomb; the underworld receives the image; the spirit seeks the stars.

---

[1] Lang: Mythology, Ritual and Religion, Vol. II, p. 25.

(Pliny.) The soul remains on earth, the shade or umbra is removed to Elysium or Tartarus, depending upon deeds.

New Testament Idea (of Jews). Paul, in "The Epistle to the Romans," chapters 8 and 13, mentions bodily soul, intellectual soul, and spiritual gifts. These convey the idea of plurality.

Mediæval Theories. Ascribed three souls to man, the vegetal, the sensitive, and the rational.

LOCALIZATION.

Where did primitive man locate the soul? There were great differences of opinion on this question. Some regarded one organ as central, some another.

The heart and pulse are often pointed out. These parts, as seat of the soul, emphasize the close connection in the belief of primitive man, between what was regarded as the soul and life itself.

Ideas in regard to the HEART are as follows:

Egyptians. The ancient Egyptians thought that the heart was the seat of the soul.

Ancient Hindus. According to the teachings of the Veda, the soul was believed to be located in the heart.

Samoyeds. The heart is believed to be the seat of the soul.

Caribs (Indians). It is thought that there are as many souls as there are pulses that can be felt. The heart soul goes to the gods; the inferior ones roam as evil spirits.

Sacs and Foxes (Indians). The heart is believed to be the seat of wisdom and of the soul.

Winnebagoes (Indians). It is believed that the Great Spirit cut a piece from his body and made man and woman.

Nicaraguan (Ind.). The heart is considered immortal, the immortal part of it making life.

Tonanese. The soul is claimed to be co-extensive with the body, but chiefly in the heart.

Aztec. The heart is considered the seat of the soul; and being the most precious part of the body it is the offering to the gods.

Chancas. The word "sonccon" is used for soul, this word also means heart.

Basutos (Negroes). It is said of the dead, his heart has gone forth.

Ashantis (Negroes). The heart is thought to be the heart of the soul.

Blood.

The blood has been thought by some to contain the soul. This was believed to be the seat of the soul because as it poured forth from the person, or perhaps an animal, life ebbed with it. Homer uses this expression:[1] "The blood flows from the wound and the life (Psuche) (ψυχη) flows from the wound." On the basis of the belief in the life principle of the blood, we have the custom, more common in the past than now, but still prevalent, of mixing of blood as symbolic of bonds of friendship.

Esthonians. Some[2] of these people will not touch blood because

[1] Robinsohn: Psychologie der Naturvölker, p. 18.

[2] Frazer: Golden Bough, Vol. I, p. 178.

they believe it contains the animal's soul. This soul would then enter their body.

N. A. Indians. Some of the Indians of North America believe that the blood contains the life and spirit of the beast and they abstain from its use. To rid the game of any evil that might befall them they pass it through smoke and flame several times to destroy the blood, life, or animal spirits.

Papuan (N. Guinea). These have held similar views about the blood.

Eastern Islanders. Animals[1] for food are stunned or suffocated. This method, it is thought, is to prevent the shedding of blood on the ground. The soul residing in the blood, any ground on which it falls becomes sacred.

Jews. As noted in Leviticus,[2] related also by Josephus,[3] the Jews would not taste the blood of animals they had killed. They either believed that the soul or life of the animal was in the blood or that the blood actually was the soul.

Arabs. These held beliefs concerning the blood similar to those of the Esthonians, N. A. Indians, Papuans, and others.

Romans. Views similar to the foregoing were held. Virgil in his Æneid[4] speaks of the purple blood as the purple soul.

Greeks. The Greek writers,[5] Empedocles, Critias and Galen identify the soul with the blood.

Bones.

Iroquois. A part of the soul was thought to be located in the bones. esken—bone, atisken—soul.

Athapascan. The bones were believed to be the seat of the soul. yani—bone, iyune—soul.

Caribs. The bones of the dead were gathered once a year.

Indians East of Miss. Most of the tribes cared for the bones of the dead.

Breath.

The root *an* furnishes many words for wind, breath, soul and spirit.

Sanskrit { Anila—wind; prana—spirit; atman—self. The word *atman* originally meant breath, then life, sometimes body; but far more freqently, the essence or the *self*.

Greek. (anemos) (νεμος)—wind.

Latin. Anima—air, wind, breath, life, soul, spirit. Animus—soul, spirit.

Irish. Anal—breath, anam—life or soul.

The breath is assumed to be the seat of life among some peoples; in most instances its relation to the idea of the soul is conveyed by different meanings attached to the word. "The analogy between soul and breath was so plain," says Baring-Gould,[6] "that it was at once concluded that they were identi-

[1] Frazer: Golden Bough, Vol. I, p. 183.
[2] Chap. xvii, 10-14.
[3] Antiquities of the Jews. Book III, Sec. 2.
[4] Book IV, p. 349.
[5] Aristotle: De. An. I, 2, 19.
[6] Origin and Development of Relig. Beliefs, p. 93.

cal, or if not identical, were very similar." Various ideas are expressed as follows:

West Australians. The word "wang" is used for breath, spirit and soul.

Malayans. The soul is said to escape from the nostrils.

Java. The word Ñava is used for breath, life and soul.

Papuans. The words for steam and fog are those used for spirit, rur itam—hot steam—hot spirit—rur aiknand—fog—tree spirits.

Seminoles. A newborn child, whose mother has died, is held above her face in order that it may inhale the escaping spirit.

Mohawks. From the root word "atourion," to breathe, is derived the word "atouritz," the soul.

Slavonian. Duh—breath, spirit; dusa—soul; dounon—to breathe; dyma—seat of force, mind.

Hungarian. Szél—wind; szellö—wind, breath; szellem—soul, spirit.

Sigourney Islanders. Tucho — breeze, breath, air, spirit; dulo tucho—Holy Ghost.

Egyptians. The words ba—soul, bas—bodily warmth, and nafi—breath, were used. In their creation myths, breath means soul.

Hebrews. The word "ruah" sometimes means wind, sometimes life or soul.

Greeks. The word (ψυχη) psuche, is breath or soul from a root expressive of blowing. Psugmos (ψυγμος)—drying effect of a blast of wind, or an effect of cold. From the same radical (πνειω) pneio, to blow,—(πνευμα) pneuma.

Costa Rica Ind. The liver was regarded as the seat of thought and memory.

New England Ind. Soul was believed to be located in the brain.

Natives of Leti, Moa, and Lake Islands. The organs of procreation are thought to be the seat of the soul.

Naudowessies. It is believed that the father gives the child its soul, the mother, its body.

The Karens. Suppose that a being called Tso resides in the upper part of the head, and while it maintains its place no harm can befall the person from the efforts of the personified passions. But if the Tso becomes weak, evil is sure to result to the person. For this reason the hair is carefully dressed and attired, and the head well cared for so as to be pleasing to the Tso.

Siamese. A similar idea is that of the Siamese,[1] who think that a spirit called the Khuan dwells in the head. This is the guardian spirit and must be well cared for, so that the acts of shaving and cutting the hair become ceremonies.

Animals.

Some tribes ascribe souls to animals alone; others, to both animals and plants, extending the idea even further sometimes, so as to include all objects that cast a shadow. Spencer[2] thinks the belief that everything has a soul has been arrived at by a process of reasoning. Beginning with man himself, the savage sees that he breathes and casts a shadow; this he identifies with his other self, or ghost. Then he notes that animals likewise breathe and cast shadows. So he concludes that they,

---

[1] Frazer: *op. cit.*, Vol. I, p. 188.

[2] Sociology, Vol. I, p. 193.

too, must have another self, or ghost. Thus, the writer thinks, they have passed on from animals to plants and other objects, and, as in the case of the Fijians, to every object. Different writers, students of the condition of primitive man, have noted that he places the animals on an equality with himself, and even regards them in some respects his superior. He will talk to them and, as Tylor[3] relates, in the case of such tribes as the Kafirs, Ainos, Samoyeds, Dyaks, and some Indians, when the game has been killed, he will offer some apology or condonation to the departed spirit of the animal. At night, as Brinton[4] notes, the ways of the animals were guided by a wit beyond the divination of the savage and they were able to gain a living with little toil or trouble. "They did not mind the darkness, so terrible to him, but through the night called one to the other in a tongue whose meaning he could not fathom, but which, he doubted not, was as full of purport as his own." They had sly and strange faculties which he recognized, and he doubted not that at one time he had possessed the instinct of his brute companions. From his close relationship, living and contending with them, we are not surprised that the savage should attribute to animals a spirit akin to his own.

Apaches. The owl, the eagle, and all perfectly white birds were regarded as possessing souls of divine origin.

Maricopas. Believe that after death they will return to their ancient home on the banks of the Colorado River. Then their heads will be turned into owls and other parts of their bodies into different animals.

Aht (Ind.). The soul is thought to issue from gulls and partridges, and after death they will return to their original forms.

Chippeways. Believe that animals have souls, also that inorganic substances, such as kettles, have in them a similar essence.

Fijians. Not only mankind, but animals, plants, and all manufactured articles are believed to possess souls.

Mexicans. Think that because every object has a shadow it has a god.

Algonquin. The hunter is thought to continue his chase in the happy hunting ground, in pursuit of the souls of his game.

The Indians of North America believed that animals had spirits and usually buried some animal with a dead warrior.

Sioux. The bear is regarded as having four souls.

Greenlander. Think that a sick human soul may be replaced with the soul of a hare, reindeer, or of a child.

Hovas of Madagascar. Ghosts of animals are sometimes seen to appear.

Maori. Spirits of dogs are believed to descend to the Hades of the departed.

Kamschadales. It is thought that every creature, even the smallest fly, will live again in the underworld.

Kukes of Assam. The ghost of every animal that the hunter kills will belong to him in the next life.

---

[3] Prim. Cult., Vol. I, p. 422.

[4] The Myths of the New World, p. 122.

Karens. The spirit of the animal is thought liable to wander and suffer injury.

Zulus. Believe that cattle will come to life again and be the property of the dwellers in the world beneath.

Siamese. The butcher beseeches the spirit of the slaughtered ox to seek a happier abode.

Greeks (Pythagoras, Plato). Believed that animals have undying souls.

Romans (Juvenal Sat. XV, 148). Lower animals are said to have the anima but not the human soul, animus.

French (Descartes). Animals are mere machines.

English (Wesley). In the next life, animals will be raised above their state in this life. Horridness will be exchanged for primeval beauty.

English (Adam Clarke). Animals do not sin, are not involved in the sins of man; cannot have adequate happiness in this life, but have it in the hereafter.

Souls Ascribed to Plants.

We find a few definite instances of this belief. No doubt if the subject were investigated more closely, at first hand, it would be found that the soul as the life principle is advocated by most savages. "Plants, partaking with animals," says Tylor,[1] "the phenomena of life and death, health and sickness, not unnaturally have some kind of soul ascribed to them." The idea of a vegetable soul was common in mediæval philosophy, and Tylor thinks that "the doctrine of the spirits of plants lay deep in the intellectual history of South East Asia," but has been superseded by Buddhistic influence.

Society Islanders. Varma, the surviving soul of man, is ascribed to plants also.

Dyaks (Borneo). Ascribe to rice a spirit, the departure of which causes decay of the crop.

Karens. Believe that plants have their souls called "la." The spirit of sickly rice may be called back.

Buddhists. The early belief of the Buddhists was divided. It was a disputed question whether, if plants had souls, they might be lawfully injured or not.

The subject, however, assumes two aspects, closely related to the belief that the plant has a soul similar to that of man. One is, that trees and plants, as held by some tribes, are the abodes of spirits. This superstition naturally leads to tree-worship. The other is, that the tree, as in the theory of transmigration, becomes for a time the resting-place of the human soul.

CONCLUSION.

In this chapter, on primitive ideas of the soul, the following data are presented: (1) Theories as to how an idea of the soul may have arisen; (2) The probable influences of the dream, shadow, breath, etc., in shaping the concept of soul; (3) Data on various aspects of the soul-idea.

---

[1] Prim. Cult., Vol. I, p. 428.

No very general conclusions can be drawn. The soul is most frequently described: first, as shadow; second, as breath; third, as wind; then as life, heart, echo, etc. The dream as the strongest influence in giving birth to an idea of the soul is revealed. This is probably not true for the child, as it is generally believed to be the result of teaching.

Different animal species exhibit certain capabilities, as flight by the birds, swiftness of foot by the deer, etc.; these are impossible feats for the savage, they are acts furnishing food for his imagination, they inspire him, and from the union of such traits he forms his ideal. That is, the inspiration of the savage is got from the special adaptations of different animal species. The primitive idea of soul cannot be classed as psychological, or philosophical. It is connected more or less with superstitious beliefs, and as such may be classified with their religion. By soul the savage probably means life, it is related to no personal God, nor is any thought of mind conveyed in the idea. It is most frequently a shadow-like form of the individual that will enjoy certain favors after death.

Greek Ideas Regarding the Soul.

It may not have been an entirely new procedure for man, to consider, in some crude way, his possessions, to measure up his stock in trade,—so to speak—to compare it with animals or other persons, to consider his power or ability and observe in some way how he is fitted to cope with his environment. It may not have been an entirely new departure for man to try to shape his destiny, to seek to discover the wherefore of his existence, to desire knowledge as to what he actually is in comparison with other things, or what he is expected to do. Is he serving a master? if so, to find out the character of this master, his will, etc., and further to learn something of the material with which he has to deal. The savage world is a great animated one, the dispositions of its numerous inhabitants being very similar to savage life. To the savage the great invisible world is sufficient to account for everything which is not directly observable by the senses. This has sufficed for a long time. It satisfied the dwellers of Greece for a long period. The spirit world is in matter, and is sufficient to account for the cause of things. That these spirits exist, the savage has strong proofs. When he sleeps his soul visits other souls of this spirit world, and when he dies the soul is free to dwell there. Everything has a soul like him; and then, too, there are many things that happen that nothing but spirits can do. This explanation did not always satisfy the Greek mind. Dwelling as they did in a country where intercourse among themselves, as inhabitants of colonies, was easy; partially shut

out from the barbaric world, no longer nomadic, they made great advancement, not only materially, in accumulation of wealth and development of the country, but intellectually, as well. The conditions were favorable for furthering the training of the mind, and were such as perhaps never existed before. With the development of the mind, there began a search for this spirit that ruled; the immortal being that ordered all things. With this search we have the beginnings of the cosmological period of their philosophy. The true relation of man to nature, or the abiding, must relate to that part of him that abides. Three periods of Greek philosophy are generally recognized. During the period of hylozoistic monism[1] the ancient Ionians regarded matter as something living; in itself it was animated just as are particular organisms. This was the first step. It was superseded by dualism in the systems of Empedocles and Anaxagoras. Then the distinction between the spiritual and the corporeal was brought out, also that between matter and force was shown by Empedocles and Democritus. The distinction of true knowledge and phenomenon is a recognition of the mental in the Eleatic school. This is taken up by the Pythagoreans. With Anaxagoras the spiritual is the principle of all being, the material without the impulse of the spirit is nothing. The advent of the idea, the concept-philosophy of Socrates, represents in Plato the dualism of mind and matter, soul and body.

Two courses of influence must be recognized in considering early Greek ideas of the soul. The early cosmologists did not take account of the individual soul in their systems, that was explained satisfactorily by their religious beliefs. The mystery with which they grappled was that of a basal material (Ionians) or fundamental form (Pythagoreans) of the world. It was only after a relation had been established between this world principle and the soul of popular belief that it came to be scientifically considered. Then it was considered in connection with the entire course of the universe.

The fundamental principle Thales declares to be water. He thinks the whole world is full of souls. The loadstone is said to have a soul because it moves iron. What he regarded as soul was something endowed with the power of motion. Why should this first principle have been water or moisture? Aristotle[2] thinks that it was perhaps because the germs of all beings are of a moist nature, or because the nourishment is moist. This is interesting as being one of the first recorded attempts to solve the mystery of life. Living near a body of water was

[1] Siebeck: Geschichte der Psychologie, pp. 27-29.
[2] Met., I, 3. 983, b. 6. (Fairbanks.)

perhaps an influential factor, for Thales thought the earth rested on water and floated like a piece of wood. The solution dealt with motion and mutability. Anaximander considered the infinite or unlimited (something) to be the primitive matter of all things, while Anaximines thought it to be air. All things spring from air by rarefaction or condensation, *i. e.*, by heating and cooling. "Air is the nearest to an immaterial thing; for since we are generated in the flow of air it is necessary that it should be infinite and abundant, because it is never exhausted." Air is the first principle of things; from this all things arise and into this they are all resolved again. "As[1] our soul which is air holds us together, so wind (*i. e.*, breath, *pneuma*) and air encompass the world." This is closely related to the ideas of many primitive peoples who associate soul with breath as the life-giving principle.

These represent the fundamental principles of the Ionic school, two substances are mentioned, the aim being rather to present the thing most essential for life, for animated matter; they were not yet interested in soul. As for Hippo and Diogenes of Apollonia, pupils in the same school, the former regarded moisture as the first principle, while the latter regarded the air as the substance of which all things consist. This substance must be eternal, unchangeable, great and powerful, and rich in knowledge. The air possesses these qualities; it is the essence in which reason dwells.

Some passages from the fragments left by Herakleitos convey some idea of what he meant by his continual flux, and the nature of primitive matter. "All[2] things are exchanged for fire, and fire for all things, as wares are exchanged for gold and gold for wares." "Fire lives in the death of earth, and air lives in the death of fire, water lives in the death of air, and earth in that of water." "Gods are mortals, men are immortals, each living in the other's death and dying in the other's life." "For to souls it is death to become water, and for water it is death to become earth; but water is formed from earth, and from water, soul." "The limits of the soul you could not discover, though traversing every path." "It is a delight to souls to become wet."

"When a man gets drunk, he is led about by a beardless boy, stumbling, not knowing whither he goes, for his soul is wet." "The dry soul is wisest and best." "It is hard to contend with passion; for whatever it desires to get it buys at the cost of soul." "All things are full of souls and of divine spirits." "Man like a light in the night is kindled and put

---

[1] Aet., I, 3. Dox., 278. (Diels.)

[2] Fairbanks: The First Philosophers of Greece, pp. 25-59.

out." Religious rites are cures for the soul. We learn from Plato and Aristotle that Herakleitos thought all things to be motion; to him nothing abides, all things in the course of time become fire. The first principle is soul, all other things consisting of a fiery exhalation from it. There is a flow of all things upward and downward; the stages are earth, water, air, fire. The qualities of soul are manifested in the exhalations of fire. Unlike the early Ionic cosmologists, we note a trace of religious teaching in his system. Two lines of thought are mingled and in some passages the soul is spoken of in a popular way signifying the person or individual. Then again a trace of the scientific is brought in; but regarding his teachings as a whole, Herakleitos is considered more of a metaphysician than physicist. The teachings of Xenophenes were contrary to the mythology of his time. According to his belief, all things come from the earth and return to it. One God rules; he is supreme. The primitive essence is the divine spirit ruling the universe. For Parmenides the truly existent has the attributes of an abstract conception of being. "Therefore thinking and that by reason of which thought exists are one and the same thing, for thou wilt not find thinking without the *being* from which it receive its name, nor is there nor will there be anything apart from being; for fate has linked it together, so that it is a whole and immovable."

"For that which thinks is the same, namely the substance of the limbs, in each and every man, for their thought is that of which there is most in them."

With Empedocles we have a duality in the sense of opposites and their effects. Love tends to make one out of many, strife tends to make many out of one. Love and strife control things. There are four original elements, fire, air, water and earth. From Aristotle we learn of Empedocles, that, "as many [1] as pay careful attention to the fact that what was soul is in motion, these assume that soul is the most important source of motion; and as many as consider that it knows and perceives beings, these say that the first principle is soul, some making more than one first principle and others making one, as Empedocles says the first principle is the product of all the elements, and each of these is soul."

"And [2] in like manner it is strange that soul should be the cause of the mixture; for the mixture of the elements does not have the same cause as flesh and bone. The result, then, will be that there are many souls through the whole body, if all things arise out of the elements that have been mingled to-

---

[1] De Anima I, 2; 404 b 7.
[2] De Anima I, 4; 408 a 14.

gether; and the cause of the mixture is harmony and soul." "The soul is a mixture[1] of what is air and ether in essence." Mind and soul are the same. The soul is imperishable. The knowledge we have of Empedocles's ideas of the soul is derived chiefly from other writers. We find that he regarded the blood as the real carrier of life; since it was thought to be the most perfect combination of the four elements. The perceptional knowledge depends upon the combination of elements, and the spiritual nature as he understood it depends upon the physical nature; that is, it is the result of certain combinations.

As to the teachings of Pythagoras and his school, we can only follow what later members say. Little is known of the early doctrine; but it is believed, however, to have been dualistic. It is supposed that they postulated world soul and that the origin of the soul of man was ascribed to this. Some of the Pythagoreans held that solar corpuscles are souls. The soul was considered to be a harmony or a number. From the doxographers we learn that "Pythagoras[2] held that one of the first principles, the monad, is god and the good, which is the origin of the One, and is itself intelligence." "Divine spirits are psychical beings; and heroes are souls separated from bodies, good heroes are good souls, bad heroes, bad souls." "For Pythagoras, who held that the soul is extended through all the nature of things and mingled with them, and that from this our souls are taken, did not see that God would be separated and torn apart by the separation of human souls; and when souls are wretched, as might happen to many, then part of God would be wretched; a thing which could not happen." The harmony of opposites and the essence of number symbolize the soul. The soul is an immortal being passing through stages of perfection in animal life. The body is the prison or tomb of the soul.

Anaxagoras taught that all things have existed from the beginning in infinitesimally small fragments, fragments of gold, fragments of flesh, etc. The task of collecting and arranging these particles was performed by mind, or reason (nous). With Anaxagoras we have an intelligent principle as the cause of motion. This was a great advance in some respects over the mechanical theories of some of the cosmologists. Soul and mind are the same; it is the moving force of matter. He thought that if a being moves itself it must be mind that produces the motion, the motive power coming not from without but from within. For him this motive principle becomes a soul. But since the *nous* exists apart from man, the mental

[1] Fairbanks: The First Philosophers of Greece, p. 226.
[2] Fairbanks: *op. loc.*, pp. 133-153.

process depends on a being outside the world, and there is no natural process of knowledge.

"Other things[1] include a portion of everything, but mind is infinite and self-powerful and mixed with nothing, but it exists alone by itself." For it is the most rarefied of all things and the purest, and it has all knowledge in regard to everything and the greatest power; over all that has life, both greater and less, mind rules. And mind ruled the rotation of the whole, so that it set it in rotation in the beginning."

From Aristotle[2] we learn that many times Anaxagoras "rightly and truly says that mind is the cause, while at other times he says it is soul; for it is in all animals." "Anaxagoras seems to say that soul and mind are different, but he treats both as one in nature except that he regards mind especially as the first principle of all things." In this system the interesting point is the dualism of mind and matter, and the attempt to define mind in relation to matter. Mind being the finest and most mobile of all matter, is first in importance, while matter becomes secondary. Man partakes of a part of this *nous*, and thus is motivated.

The Atomists, especially Leucippus and Democritus, teach that everything is reducible to the full and the void. Being fills space, non-being, void. Being consists of matter, but matter is composed of minute indivisible atoms. These are underived, imperishable and homogeneous, differing *only* in size and form. There is an infinite number of forms of atoms, mechanical necessity being the unifying principle of the system. The most important element is fire. It consists of the finest atoms, these being smooth and round, and the smallest of all. It is the principle of motion[3] in organisms. These fiery particles are diffused throughout the whole body. There is a soul atom between every pair of body atoms, but the various faculties of the soul have their seat in different parts of the body; thought in the brain, anger in the heart, desire in the liver. On account of the fineness of the soul's atoms, there is danger lest they be forced out of the body by the air that surrounds us; this loss is overcome by inspiration. The body is only the vessel of the soul, and on the latter we should bestow more care than on the former. The excellence of the animal consists in bodily perfection; of man, in moral perfection. The soul is something corporeal like all other things, but more than that, it is the most perfect body. The soul distributed throughout the whole universe is the Deity. Sensation and consciousness are a consequence of the mobility of soul atoms. Thought

[1] Burnett: Early Greek Phil., p. 293.
[2] De Anim. I; 2,404 b.
[3] Zeller: Pre-Socratic Philos., Vol. II, pp. 256-270.

and perception have the same origin; both are material changes of the soul's body, and are occasioned by external impressions —the impact of atoms entering the sense organs.

The elements of early science, combined in the system of Democritus resulted in materialism. The same elements, from the point of view of the Socratic concept, formed the idealistic system of Plato. Socrates, the immediate precursor of Plato, considers the soul to be immortal. His teachings are based entirely on morals; man for him means a seat of moral ideas. For Plato God made the soul out of the following elements: "out[1] of the indivisible and unchangeable, and also out of that which is divisible and has to do with material bodies, he compounded a third and intermediate kind of essence, partaking of the nature of the same and of the other, and this compound he placed, accordingly, in a mean between the indivisible and the divisible and material. He took the three elements of the same, the other, and the essence and mingled them into one form, compressing by force the reluctant and unsociable nature of the other into the same." This is the soul of the universe, and of this, in a diluted form, the stars partake. The offspring of the divine imitating him, "received[2] from him the immortal principle of the soul; and around this they proceeded to fashion a mortal body, and made it to be the vehicle of the soul, and constructed within the body a soul of another nature which was mortal, subject to terrible and irresistible affections . . . they gave to the mental nature a separate habitation in another part of the body." "And in the breast and in what is termed the thorax they encased the mortal soul." "That part of the inferior soul which is endowed with courage and passion and loves contention they settled nearer the head, midway between the midriff and the neck in order that it might be under the rule of reason. . . . . . That part of the soul which desires meats and drinks and the other things of which it has need by reason of the bodily nature, they placed between the midriff and the boundary of the navel, contriving in all this region a sort of manger for the food of the body." God gave the "sovereign part of the human soul to be the divinity of each one," this part dwells at the top of the body. The soul existed before it entered the body and had intelligence,—memory still retains certain forms of knowledge—"absolute beauty, and goodness, and essence in general." If these[3] absolute ideas existed before we were born then our soul must have existed before we were born.

---

[1] Timaeus: Jowett, Vol. III, p. 453.
[2] *Ibid.*, p. 491.
[3] Phædo.

The soul is immortal,[1] for that is immortal which is ever in motion; that is, self-moving. Ten thousand years must elapse before the soul can return to the place from which it came; it may then pass into the life of a beast or into a man again. For the lover of knowledge the soul is glued to the body, viewing existence through the bars of a prison. The soul is lasting, the body, weak and short-lived, and every soul may be said to wear out several bodies.

The soul, belonging to the supersensible world, has the qualities of non-origination, indestructibility, unity and changelessness. Since it is the carrier of the idea of life, the cause of its own motion, it is not identical with the ideas. The part relating to the ideas is the directing, reasoning part. The part located in the breast, or courage, belongs to animals; while that found in the lower regions,—that is, desire, or appetite, belongs to plants and animals. These three parts represent three essences combined with each other, and not one essence operating in a three-fold manner,—the soul being their unity. "Each degree[2] has its own theoretic and practical functions in such a way that the lower functions may exist without the higher, but the higher appear in connection with the lower."

One advance which Aristotle made over Platonism was based on his insight into the insufficiency of the theory of ideas to explain empirical facts. The super-sensible world of ideas and the world of sense are identical; the universal does not have a higher actuality, separated from sense objects. Nature is the organic bond of all individuals, which actualize their form in motion, pure form being their highest purpose. Windelband[3] recognizes two parts to Aristotle's psychology, revealing two scientific points of view. (1) The general theory of animal souls, psychical processes possessed in common by animals and men, though more perfectly developed in man; (2) the doctrine of the *nous* as the distinctive possession of man, this view representing the empirical and the speculative sides of his psychology. The soul being that which holds the body together, is indivisible, and has no parts. "It is[4] the first entelechy of a natural organized body, having life in potentiality. A double meaning is implied in this definition; either it is the actualization of matter or it is the agent of actualization.

"The soul is not any variety of body, but it cannot be without a body; it is not a body, but it is something belonging to or related to a body; and for this reason it is in a body, and in

[1] Phædrus: Jowett, Vol. I, p. 579.
[2] Windelband: Hist. of Ancient Phil., p. 207.
[3] History of Ancient Phil., p. 276.
[4] Grote: Aristotle, p. 458.

a body of such or such potentialities." We do not say that the soul weaves or builds; we say that the animated subject, the aggregate of soul and body, the man, weaves or builds. So we ought also to say, not that the soul feels anger, pity, love, hatred, etc., or that the soul learns, reasons, recollects, etc., but that the man with his soul does these things. The actual movement throughout these processes is not in the soul, but in the body, sometimes going to the soul (as in sensible perception), sometimes proceeding from the soul to the body (as in the case of reminiscence). Defects in the soul arise from defects in the bodily organism. This is not less true of the *nous*, or intellective soul than of the sentient soul.

"The varieties of soul are distributed into successive stages, gradually narrowing in extension and enlarging in comprehension; the first or lowest stage being co-extensive with the whole, but connoting only two or three simple attributes; the second or next above, connoting all these and more besides, but denoting only part of the individuals denoted by the first. The third, connoting all this and more, but denoting yet fewer individuals, and so on forward." This lower stage is co-existent with life, including both plants and animals.

The nutritive soul connotes only nutrition, growth, decay, and generation of another individual. The sentient soul, belonging to animals, but not belonging to plants, connotes all the functions and faculties of the nutritive soul, and sensible perception (at least in its rudest shape) besides. "We[1] proceed onward in the same direction, taking in additional faculties,—the movent, appetitive, phantastic, noetic soul, and thus diminishing the total of individuals denoted. But each higher variety of soul continues to possess all the faculties of the lower. Thus the sentient soul cannot exist without comprehending all the faculties of the nutritive, though the nutritive exists (in plants) without any admixture of the sentient. Again, the sentient soul does not necessarily possess either memory, imagination or intellect (*nous*); but no soul can be either imaginative or noetic without being sentient as well as nutritive. The noetic soul, as the highest of all, retains in itself all the lower faculties; but these are found to exist apart from it."

Plato's system takes note of three essences, these mingling together form a soul. Aristotle recognizes but one, with different forms of manifestation. The *nous* is not connected with or dependent upon any given bodily organs or movements appropriated to itself; this distinguishes it from the sentient and nutrient parts, which are localized to a certain extent.

---

[1] Grote: Aristotle, p. 461.

The sentient soul is complete from birth, while the *nous* or the noetic soul enters from without and emanates from the divine celestial substance, the region of Form; the celestial body surrounding the cosmos, and every form that animates matter derive its vitalizing influence from it. But the *nous* belongs essentially to the divine; it comes from without, being a small fraction of the whole soul. There are but few men in whom it is much developed. It is put into action by the abstract and universal, in a certain sense within the soul itself. Of the *nous* the *Intellectus agens* is the constructive function, and the *Intellectus Patiens* the receptive function; the first deals with the universal, it alone being immortal, while the latter agency ceases with the existence of the body. The animal soul is differentiated from the vegetable, principally, because of a greater degree of concentration. The fundamental activity of the soul is thought.

After Plato and Aristotle, no new systems of Greek philosophy were set forth. Greek civilization had begun to decay; the later philosophers were content to follow along in the lines of one or the other of the two great leaders. "Criticism, appropriation, readjustment and remodelling" occupied the minds of the later Greeks and early Romans.

The two schools most sharply distinguished are those of the Stoics and Epicureans. With the decline of the Grecian states, philosophy took on a practical turn; and with Grecian helplessness we have Stoic apathy and Epicurean self-contentment,—peace of mind being the only way to happiness. The central point of the Stoic doctrines is a certain ethical standard, the ideal of the wise man. The moral[1] conduct of man is the chief business of philosophy.

"The matter[2] or substance of which all things are made is corporeal," it is infinitely divisible, everything is subject to change. Heat and cold are the two active elements. In their materialistic view of the world they regard the soul as corporeal. Whatever influences the body, or is united with it, or is itself influenced by it and again separated from it, must be corporeal. It has extension in three dimensions over the body, and whatever has three dimensions is corporeal. Animal life, the cause of thought and motion, is kept in health and nurtured by the breath, therefore the mind is nothing but fiery breath. For some Stoics the soul is fire or breath, or warm breath diffused throughout the body. The warm breath is connected with the blood, the soul being fed by its vapors as the stars are fed by vapors from the earth. One part of the

---

[1]Zeller: Stoics, Epicureans and Sceptics, p. 56.
[2]*Ibid.*, p. 194, *seq.*

soul is transmitted to the young in the seed. There arises, by development within the womb, first the soul of a plant; this becomes the soul of a living creature, after birth, by the action of the outer air. Some thought the soul must reside in the breast, because the voice bearing the thought arises in that part of the body; others thought it was located in the head. For the former location, eight parts of it were recognized; the *hegemonicon* or governing part, situated in the breast, the five senses, the faculty of speech, and the generative force. The soul is a unity, reason or the *hegemonicon* is the primary power; the other powers are parts of this,—derived from it. Feeling and desire are also derived from it. The individual soul is related to the soul of the universe as a part to the whole. It does not possess activity independent of the world-soul, neither may it last till the end of the world's course.

The Epicureans likewise held a materialistic view. According to their system of philosophy, knowledge of natural causes is the only means of liberating the soul from superstition. This is the value of natural science; the thought of God and the fear of death compelling us to study nature. Bodily reality is the only form, corporeal,[1] the only substance. The origin of the world is the result of atomic unity. The soul is a body, but is composed of the finest, lightest and most easily moved atoms; this is proven by the speed of thought, instantaneous dissolution of the soul at death, and the fact that the soulless or dead body loses no weight. For Epicurus[2] the soul is the cause of feeling; the elements of it are received by the child from the parent's soul at the time of generation, it is spread over the whole body and grows as the body grows. The rational part has its seat in the breast; the irrational part is diffused as a principle of life over the whole body. Mental activity, sensation and perception, the motion of the will and the mind belong to the rational part. The mind may be cheerful while the irrational soul may feel pain, or the latter may be lost by the mutilation of the body—without detriment to the rational soul. The soul cannot exist when its connection with the body is severed, its light atoms are dispersed in a moment. When the soul is destroyed the body is also destroyed, for it cannot exist without the soul. Atomic particles thrown off by bodies, come in contact with our bodies and cause sensations.

Among the Eclectics, the later philosophers attempted to blend the different schools. Asclepiades thought the soul to be the whole compounded of all the senses, with a substratum, the *pneuma*, consisting of light round particles. Posidonius

---

[1] Zellar: Stoics, Epicureans and Sceptics, p. 439.
[2] *Ibid.*, p. 454.

thought the emotions arose, not from the rational soul, but from courage and desire, two separate faculties, distinct from reason. Cicero regarded the soul as an emanation from the Deity, an essence of supernatural origin.

If we glance back briefly over Greek philosophy as a whole, we find, in this retrospective view, a general tendency toward idealism.

The early cosmologists made no break with their mythical religion, but sought rather the basis of matter, the enduring part of it; or, in other words, since matter was considered to be animated, they sought that on which the life principle depended. A gradual dualism was formed, which resulted in the idealism of Plato, the stages of which may be traced as follows: (1) the teachings of Empedocles, embracing the theory of opposites; (2) the form of Pythagoras, believed to represent dualism; (3) the *nous* of Anaxagoras, in which the mind was predominant over matter.

Explanations of mental phenomena tend to sever the connection of soul with the life function and associate it with mind. The development of ethics has been instrumental in this change of idea. Localization of a part of the soul in the region of the abdomen, harmonizes with the modern theory of the emotions. Greek theorists regarded the soul as a substance, many of them taught that it was composed of particles of matter of some kind.

Theological Ideas of the Soul.

Any historical study of the soul beginning with the decline of Greek Philosophy, must recognize the following principles: (1) religious ideas of the soul are oldest, are found among all primitive peoples, have existed at all stages of civilization, and form whatever ideas of the soul most civilized peoples have today; (2) from time to time certain philosophers have attempted to define the soul on the basis of the relationship between God, the universe and man; (3) more recent psychologists have attempted to state the relation existing between the soul and the mind. Keeping these principles in mind, the writer has thought best to treat the subject under the following headings: Theological, Philosophical, and Psychological theories of the soul.

The Theological Idea. The conception of the soul formed as the result of religious teaching is more common than that derived from any other source. That is, while there may be no generalized idea of it in which all people agree, the masses of the people, if they have any formulated idea of its existence, have probably gotten it through their religious teachings, it being in definite relations to their idea of God. The idea in-

volves a material substance of some kind, which, as such, continues to exist after the death of the individual. In fact, so general is such a belief among religious peoples (and little removed from the primitive idea yet), especially among Christians, that here in this crude yet general belief a great soil or matrix is formed which has almost become inherent. The theological standpoint is least removed from that of primitive man, is more generalized than any other, and so naturally falls first in the line of treatment. Hagenbach[1] observes: "The inquiry into the origin of the human soul, and the mode of its union with the body seems to be purely metaphysical, and to have no bearing upon religion. But, in a religious point of view, it is always of importance that the soul should be considered *as a creature of God*. This doctrine was maintained by the Catholic church in opposition to the Gnostic and heretical theory of emanations."

An historical treatment of the subject, from the monotheistic point of view existing in Christian religions to-day, has more meaning if we take up the threads of connection that lead back to Grecian philosophy, and especially those that lead to Jewish theology. At the time of the Christian era these two lines of influence had begun to mingle. This is noticeable in the material ideas of the later Stoics; the doctrines of this school is an elective one, many of their teachers are essentially Christian, while they attempt to cling to Grecian philosophy. The immediate influence of this school was most potent on the early Christians. The stoics taught that the Pneuma (πνευμα) is corporeal, yet it has the attributes of mind. In this is a trace of the influence of Hebrew doctrines. For the latter the word *Ruach*, corresponding to Pneuma (πνευμα) had a material meaning, *i. e.*, it meant something that God breathed into man. It was for them a semi-force, a vital element at least, something that could exist apart from God. Philosophers before the time of the Stoics had regarded the Pneuma (πνευμα) as the vital force of the body, and in fact the soul itself; but the latter class looked upon everything that is real as being corporeal, and the human soul as a fragment of God. The main channel, so to speak, of Grecian philosophy culminated in the teachings of Plato, terminating in idealism; this line of thought was further worked out in Neo-platonism. The systems of Greek philosophy, condemned and pointed out the errors of the early Greek religions, but offered no substitute. The effect of this was that the later Greeks, without a satisfactory religion, were ready to take over and work into their systems of philosophy, what seemed best of the teachings of Christ. Stoic[2] philosophy rep-

[1] History of Doctrine, Vol. I, p. 211.

[2] Drummond: Jewish Alexandrian Philos., Vol. I, p. 131.

resents a transition; the two streams of influence mingle and were brought together by them.

The doctrine of the Logos reached its highest development with them prior to the Jewish and Christian influences. Their later doctrine is really a passage from philosophy to religion; from a system of thought elaborately worked out to the bold declaration of truths borne in upon the mind, announced as the word of God, but without system. The work of outlining and harmonizing these conflicting streams of thought constituted the chief debates and discussions of the church Fathers. Their conception of the soul must harmonize with the teachings of the Bible, the ideas previously held by the Jews, and the Christian concept in general. This concept represented it as something similar to breath, as something material that might influence or be influenced for good or evil, or that might endure suffering, or enjoy pleasures.

Some of the Church fathers accepted the Neo-platonic doctrines, this being true especially of those located in Greece and Egypt; while the Latin Fathers, as Tertullian, Arnobius and Lactantius, rejected philosophy as a heathen product, which must be avoided. But the[1] very opposition of Christian doctrine to early philosophy compelled the Fathers to study the latter to offset attacks and in this way it came more readily to be reduced to dogma, to be formulated and systematized.

Of the different ideas of the soul's origin, Alger[2] mentions six, four of which have been held at different periods and debated by the Church Fathers. The first he mentions is that of emanation. This theory is constructed from the results of observation by analogy. It is a wide-spread belief of the present day, being one of the teachings of Hindu philosophy. Some of the analogies on which it is based are: the annual developments of vegetable life from the bosom of the earth; the preservation of the properties of drops of water taken from a fountain; the separation of the air into breaths, and the soil into atoms; the utterances of tone gradually dying away into echoes; the radiation of light from a central origin, etc. The second theory of the soul's origin is that of a previous existence. This view was wide-spread among oriental thinkers, also among Greek philosophers and some of the early Church fathers. There are two forms of the doctrine: one, that the soul has existed below man and is on an ascent upward; the other, that the former existence of it has been above that of man and that voluntarily, or from some cause it has descended to the rank of man. The third view is that the soul is created directly by the volun-

[1] Weber: History of Phil., p. 186.
[2] The Doctrine of a Future Life, pp. 410.

tary power of God. The ideas of this theory have been modified at times, some holding that all souls were created by a divine decree at the beginning of the world, while later theologians of the middle ages claimed that God breathes a soul into each new being. A fourth theory, held by Tertullian, was that of Traduction; that is, that all human souls have been brought over from the soul of Adam. The two views of the theory are: (1) All souls are developed out of the one substance of Adam's soul; (2) the eating of the forbidden fruit corrupted all the vital fluids of the original Mother Eve. All these theories have their objections. Viewed from the standpoint of modern science, some of them seem absurd, yet they served a valuable purpose in their time and place.

Draper[1] notes that there are two systems of philosophy. One recognizes a personal God, who exists apart and creates the immortal souls of men; the other recognizes an Impersonal Intelligence—an indeterminate God, from whom the soul emerges and to whom it again returns. Under the latter system, beings are created from nothing or developed through an evolutionary process.

Philo[2] the Jew was one of the earliest of those whose writings tended to unite Judaism and Hellenism. He taught that we possess life or soul in common with the irrational animals; but that the power of intelligence is peculiar to mind. Man is a dual, soul and body, and forms the borderland between the mortal and the immortal, the earthly and the divine. The soul possesses three properties: perception, by means of which the mind receives impressions through the senses, mental representations, and impulse. Impressions received through the senses are stamped on the mind like a ring or seal, like an impress made upon wax, and so are capable of being reproduced. They are retained until oblivion. Impulses fall either under the heading of aversion, or of desire. Man differs from the brute in that he is "two-natured," animal and man. The animal shares the vital power with the irrational creatures; man possesses the rational principle in addition to the vital element, and these constitute the soul. Like Plato he distinguishes three parts of the soul, one part being rational, a second, high spirited, third, he represents as the seat of desire. The irrational soul is explained in a way that harmonizes with the view expressed by Moses[3] in the Old Testament, *viz.*: "The soul of all flesh is blood." Mind is God to the irrational soul. This rational principle, *nous*, mind, was thought to consist of an "ethereal fire nature," yet spirit (with which it was

[1] Conflict between Religion and Science, p. 140.
[2] Jewish Alexandrian Philosophy. Drummond. Vol. I, pp. 314-59.
[3] Gen. IX, 4.

supposed to be in connection) was regarded as incorporeal. Justin Martyr, Athenagoras and Theophilus were three of the early Roman Fathers who lived soon after the time of Philo. They recognized in the teachings of the Greek philosophers the activity of the Divine Logos. The early Greek writers, McConnell thinks,[1] brought to the new religion the Platonic idea that the individual soul is indestructible, is, in fact, an articulate portion of the substance of the mind of God. Those of Roman antecedent having no inherited beliefs in a future life of any kind were better prepared to comprehend the truth of Christ. The interaction of all these fragments of earlier philosophy produced a confusion and uncertainty of mind which was not clarified for five centuries. For Justin Martyr body and soul constitute one whole; like oxen they made one team, being able to accomplish alone as little as one ox in plowing. He expects the resurrection both of the just and the unjust. A proof of this is the recognized fact that departed human souls are even now in a state of sensation; they may be evoked by Magi and Seers.

Theophilus[2] expresses himself thus: "If thou sayest, 'show me thy God,' I answer, 'show me thy man, and I will show thee my God.' Show me first whether the eyes of the soul see and the ears of the heart hear; for as the eyes of the body perceive earthly things, light and darkness, white and black, beauty and deformity, etc., so the ears of the heart and the eyes of the soul can perceive God. God is seen by those who can see Him when they open the eyes of their soul. . . . . . The eyes of the soul are darkened by sin, even by their sinful actions. Like a bright mirror, man must have a pure soul. If there be any rust on the mirror, man cannot see the reflection of his countenance in it; likewise, if there be sin in man, he cannot see God."

Clement of Alexandria mentions a tenfold division[3] of man analogous to the decalogue, the basis of the division being the more general one of body, soul, and spirit. He follows the example of Plato and divides the soul into three faculties.

Writers of Christian philosophy have usually indicated certain well defined periods of time as characteristic of some particular phase of the subject. There are several of these classifications. According to Hagenbach the first period in the development of Christian philosophy, extending to the death of Origen, is that of Apologetics; the second, from 254 A. D. to 730, is the age of polemics.

In his philosophical teaching Origen was an idealist and in part

[1] The Evolution of Immortality, p. 46.
[2] Hagenbach: History of Doctrine, Vol. I, p. 136.
[3] *Ibid.*, p. 210.

represented the Platonic idea and also the doctrine of Aristotle, while at the same time he was conforming to Jewish theology. He believed in the pre-existence of the soul, and regarded its incarnation as a punishment for former sins. Matter, he thought, is not external; it is the root of evil in man. The Bible was held to be inspired. By inspiration[1] he meant "not the pouring in of foreign thoughts, but an exaltation of the powers of the soul, whereby prophets were elevated to a knowledge of the truth." The soul is immortal, the resurrected body perhaps takes the shape of a sphere. This latter view was also held by some of his followers. As a proof of the pre-existence of the soul he cited scripture in the following: [2] "If the soul of man is formed only with the body, how could Jacob supplant his brother in the womb, and John leap in the womb at the salutation of Mary?"

The ideas of Tertullian[3] were in many respects opposed to those of Origen. He is regarded as one of the Christian philosophers, though he was materialistic in his conception, and taught Stoic doctrine. He recognized two parts of man: soul and body; both material, and both having the same form. The soul, he thought, is delicate, luminous, and aeriform, in substance; for if it were not material it could not be acted upon by the body, nor would it be capable of suffering, and its existence would not depend upon the nourishing of the latter. The soul of the child comes from the semen of the father, like a shoot from the parent-stock of a plant. Every human soul is a branch of Adam's soul. The spiritual qualities of the parents are transmitted to the children, hence the universal sinfulness of the children of Adam. Associated with the name of Tertullian we have the doctrine of Traducianism, he being generally regarded as the founder of this. The doctrine is, that souls are propagated by souls as bodies are by bodies. This was a prevailing belief until the time of Anselm. The Apostolic[4] Constitutions teach that in the primal beginning, likewise after conception, God creates the soul into that which is becoming man.

The teachings of Origen and Tertullian may be contrasted as follows: The former was an idealist to the extent of abstracting everything from God that would tend to bring him down towards men. God is animate, but sustains and fills the world. The term "man" is often used for man's spiritual part, conveying the idea that man consists essentially of soul. The soul pre-exists; death by sin is separation from God; the

[1] Hagenbach: *op. cit.*, p. 120.
[2] *Ibid.*, p. 212.
[3] Ueberweg: Hist. of Phil., p. 305.
[4] Delitzsch: System of Bib. Psychology, p. 129.

blessed dwell in the aerial regions, paradise is a happy island; after death the soul passes through successive stages of happiness, arriving at last, after the final judgment, to the perfection of blessedness, the Kingdom of Heaven. This represents the idealism of the east, peculiar to the Alexandrian school. Tertullian uses figures from the human form to describe God: eyes, ears, tongue, hands, feet, etc., being associated by him. The soul is corporeal, having the outlines of the body,—it does not pre-exist; it is reflected in man, and is immortal, the body and soul are united after the final resurrection. Tertullian, having been born in Carthage, reflects more truly the state of affairs as found in the West.

The doctrines of Arnobius and Lactantius may be considered together, since these two African Fathers were associated as teacher and pupil. The former opposed the Platonic doctrine of the reminiscence of knowledge, and denied that the soul is by nature immortal, for this must be an act of God's grace; the latter believed in the doctrine of Creationism. His belief in immortality he justified on the grounds: (1) of the testimony of the scriptures; (2) since God is incorporeal, and can exist without a body, we may believe as much for the soul. The soul is born with the body, and as opposed to the idea of Traducianism, he argued that intelligent parents sometimes have stupid children, and *vice versa*. The shaping influence of ideas, as those expressed, is often found in the ground work of a larger movement,—they may represent merely the reflection of other forces at work—such an one was Neo-platonism. This movement in thought was the culmination of Greek philosophy. The germ deposited by Philo was developing into a vital theology and an endeavor to found a new church was being made. The doctrines set forth in Neo-platonism were chiefly ethical; God was defined as an abstraction, and unlike the Christian movement was impersonally related to man. Plotinus was the chief exponent. His teachings and the teachings of Neo-platonism in general, had its influence on church doctrines, on the side of idealizing thought and leading toward mysticism. Plotinus[1] thought the soul was the image εἴδωλα and product of the *nous*, just as the *nous* is of the One. The soul is inferior to the *nous*, though none the less divine, and endowed with generative force. Coming forth from the *nous* (it includes in itself the world of ideas) the soul extends itself, as it were, into the corporeal, just as the point extended becomes a line; there is, therefore, in the soul an ideal, indivisible element, and a divisible element which goes to produce the material world. The soul is an immaterial substance, not a body,

---

[1] Ueberweg: Hist. of Phil., Vol. I, p. 249.

not the harmony nor the entelechy of the body, but inseparable from the latter, since not only the *nous*, but also memory and even the faculty of perception and the psychical force which molds the body, are separable from the body. The soul permeates the body as fire permeates the air.

It is more correct to say that the body is in the soul than that the soul is in the body; there is, therefore, a portion of the soul in which there is no body, a portion for whose functioning the co-operation of the body is unnecessary. But neither are the sensuous faculties lodged in the body, whether in its individual parts or in the body as a whole; they are merely present with the body, the soul lending to each bodily organ the force necessary for the execution of its functions. Thus the soul is present not only in the individual parts of the body, but in the whole body, and present everywhere in its entity, not divided among the different parts of the body; it is entirely in the whole body, and entirely in every part. The soul[1] is divided, because it is in all parts of the body, and it is undivided, because it is entirely in all parts and in every part. The soul is *per se* indivisible, being divided only as related to the bodies into which it enters since these could not receive it if it remained undivided. It is essentially in the *nous*, as the *nous* is in the *one;* but the soul contains the body. The Divine extends from the One to the soul. The soul, in virtue of its mobility, begets the corporeal.

The soul stands between the *nous* and the phenomenal world; the *nous* penetrates and illumines it, but the soul itself comes in contact with the phenomenal world. Its nature and definition identifies it with a world soul, composed of many of like nature. As pure intelligence it has neither appetite nor desire; the part which is inferior to intelligence, and capable of having desire, proceeds from the intelligible world. The soul, at first, shares with the universal soul the care of administering the entire world, without entering it; afterwards wishing to administer part of it only, it separates itself from the universal soul and passes into a body. But even then it does not give itself entirely to the body, for a part of it remains outside of the body; thus its intelligence remains impassible.

Plotinus taught the doctrine of Emanation. This he presented somewhat as follows: the universal soul embraces a multitude of individual souls; these being desirous of a separate existence, independent, separate themselves from the soul, —the great common principle—and enter a body. These individual parts are perfect in themselves. They finally return, after their mission is fulfilled, to this absolute unity. This

---

[1] Harnack: Lehrbuch der Dogmengeschichte, p. 776.

doctrine is found in the Buddhistic teachings, according to which the soul gradually reaches Nirvana. Averroes presented it among the Saracens. In their religion[1] it is claimed that the intelligent principle or soul at death is absorbed in the universal mind, or active intelligence, the mundane soul,—which is God, from which it emanated. The individual, or passive, or subjective intellect is an emanation from the universal, and constitutes the soul of man. In one sense it ends with the body, in a higher it endures, absorbed by the world soul, in unity with it. Vedic theology teaches that "There is in truth but one Deity, the supreme spirit; he is of the same nature as the soul of man." The Institutes of Menu affirm that the soul emanates from the all-pervading Intellect, so is destined to be reabsorbed.

Since the work of the early Fathers was largely that of presenting and defending Christianity, it dealt more with the historical past and what had been taught than with a strict analysis of their own experiences. The first one to really begin an analysis of the mind and the inner experiences, was Gregory of Nyssa. He was followed soon after by Augustine, of whom it was said that he established the Christian doctrine of the soul once for all. Gregory of Nyssa is considered by some[2] the most important of the Oriental Church Fathers. He regarded man as the highest unfolding of psychical life, "the crown of creation, its master and its king." The idealization of the world of sense was the chief feature in his analysis of this psychical life, nature was transformed into psychical terms, reality was recognized in spiritual ideas. The soul is a "self-sufficient substance[3], which is always in motion, and to which rest would be annihilation. It fills the body not materially, but dynamically, as light penetrates the air. It is not properly speaking in the body, the body is in it. The power[4] of thought is not an attribute of matter, if it were, matter would show itself endowed with it, combine the elements, and form works of art. As separable from matter, the soul in its substantial existence is like God, resembling him as a copy resembles the original. Since it is simple and uncompounded, the soul survives the dissolution of the composite body, whose scattered elements it continues and will continue to accompany, as if watching over its property, until the resurrection, when it will clothe itself in them anew. The essence of the soul does not contain anger and desire; these belong to its varying states; they are not originally a part of ourselves and we must get rid

[1] Draper: Conflict Between Religion and Science, p. 139.
[2] Windelband: Hist. of Phil, p. 254.
[3] Janet and Seailles: Hist. of the Problems of Philos. Vol. II,, p. 193.
[4] De Hom: pp. 192-206.

of them, they mark us with the brutes. Our bodies are like the coats of skins with which our first parents were clothed after the fall; they are transient.

The consummation of all these beliefs and doctrines was reached in Augustine. In all times the masses of the people have been led in their beliefs by the advance guard,—a power usually centered in one person. St. Augustine represents the high water mark of his era, and at the same time marks the beginning of a new. The only theologian of the practical Roman type of mind that had produced thus far a philosophical consideration of his faith. It has been said of him that "No[1] single man has ever exercised such a power over the Christian Church and no one mind ever made such an impression upon Christian thought." If the doctrines of the church have any influence in moulding our theological ideas, then Augustine has had a great influence. Dogma was perfected with his system. He taught[2] that the soul is immaterial, there are found in it only functions, such as thought, knowing, willing and remembrance. It is a substance or subject and not a mere attribute of the body. It is spiritual because it is the subject of thought, that is, it cannot be an attribute of that which does not think. It feels each affection of the body at that point where the affection takes place, without being obliged to move itself to that place; it is, therefore, wholly present within the entire body, and in each part of it,—while the corporeal with each of its parts is only in one place. A body has only figure, one form; it cannot become the figure and form of another body; the mind can in loving, love both itself and that which is other than itself; in knowing, know itself and that which is other than itself; hence, while memory, intellect and will share in the substantiality of the mind, they differ in this respect from mere accidents, as color, or form, of a substratum. Understanding can know itself, memory can remember that we possess memory, *i. e.*, the soul is conscious of itself as such and each of its parts. The union of soul and body cannot be scientifically explained for man is, as it were, a third substance formed out of two heterogeneous substances. The body does not act on the soul, it is the soul in the body acting on itself. The metaphysics of Augustine is built up on the knowledge of the finite personality. The three aspects of the psychic reality are idea, judgment, and will, and from these he seeks to gain an analogical idea of the mystery of the Trinity. Will is the central element of consciousness. "The leading[3] motive

---

[1] Very Rev. J. Tulloch: Enc. Brit., Vol. III, p. 75.
[2] Ueberweg: Hist. of Phil., Vol. I, p. 342.
[3] Windelband: Hist. of Phil., p. 281.

in this is doubtless the man's (Augustine) own experience; himself a nature ardent and strong in will, as he examined and scrutinized his own personality he came upon the will as its inmost core." The becoming conscious of an act of perception is an act of the will. Physical attention and likewise activity of inner sense have a dependence on the will. Whether we bring our states and actions to consciousness, the thinking of the intellect, judging and reasoning,—all these is determined by the will for it determines the " direction and the end according to which the data of outer or inner experience are to be brought under the general truths of rational insight."

The existence[1] of the soul is proved by thought, consciousness and memory. If one is in doubt as to his existence, to doubt, means to think, and to think *is* to exist. If the soul were made of fire, or air, or any other material, we would know it by an immediate perception, its substance differs from all known matter, and matter in general, for it contains the notions of the point, the line, length, breadth, and other conceptions, which are incorporeal. The immortality of it follows from its rational nature. Reason brings the soul into communion with the eternal truth, in fact the soul and truth are, as it were, one substance. The human soul is passive, receptive, and contemplative, death to it means its separation from truth. The senses furnish it knowledge, of sensible things, the spirit is instrumental in giving the soul knowledge of a moral or a religious character, a terrestrial light surrounds the corporeal body, a spiritual light environs the soul; this interior light is God himself dwelling within us. The history of mankind is divided into six periods corresponding to the six days of creation, in the last of these we live.

There are general ideas which have the same objective validity for every one, and are not like the sense perceptions conditioned by subjective conditions. Mathematical truths are of this kind, as $2+3=5$; the higher metaphysical truth belongs to this class, *i. e.*, it is truth in itself, absolute. This absolute truth demanded by the mind is God himself. Reasoning in this way Augustine is said to have given the first proof of the existence of God. The principal points of his doctrine may be stated as follows: The soul exists, it can be proven, it is a substance, its origin is in God, it is immortal and does not pre-exist; it grows from two sources, the external world and the spiritual world; separation from truth is sin, its basis is in the will.

The activity of the church in forming doctrine ceased with the creed set forth by Augustine. Adjustment internally is the

[1] Siebeck: Geschichte der Psychologie, Part II, pp. 381-397.

next step. How far the influence of Augustine's doctrine would extend was not comprehended at that time. But to the time of the Reformation, in church controversies, reformers identified themselves in many instances as in favor of or opposed to certain of Augustine's theses. Mention may be made of two or three of Augustine's contemporaries or successors. They contribute little, but it is interesting to note that they take up the threads of analysis.

Nemesius[1] discussed the soul from a psychological standpoint; it is an immaterial substance, involved in incessant and self-produced motion. From it the body receives its motion. It existed before it entered the body. It is eternal, like all suprasensible things. It is not true that new souls are constantly coming into existence, whether by generation or by direct creation. The opinion is also false that the world is destined to be destroyed when the number of souls shall have become complete. Nemesius rejects the doctrine of the world-soul and of metempsychosis; in considering the separate faculties of the soul, in regard to the freedom of the will he follows Aristotle.

Claudianus Mamertus[2] claimed that all creatures, and therefore, the soul among them, fall within the sphere of the categories; the soul is a substance and has quality; but it is not, like material substances, subject to all the categories; in particular, quantity in the usual spatial sense of the term, cannot be predicted of it; it has magnitude, but only as regards virtue and intelligence. The motion of the soul takes place only in time and not like that of material objects, in time and space together. The world, in order to be complete, must contain all species of existences, the immaterial, therefore, as well as the material. The former of these resembles God by its non-quantitative and spaceless character, and is superior to material objects, while, by its creature-ship and its subjection to the category of quality and to motion in time, it differs from the unqualitative and eternal God, and resembles the material world. The soul is not by, but environs the body, which it holds together.

Cassiodorus[3] thought that man alone has a substantial and immortal soul, the life of the irrational animals has its seat in their blood. The human soul, in virtue of its rationality, is not, indeed, a part of God, for it is not unchangeable, but it can determine itself to evil, and at the same time is capable, through virtue, of making itself like God; it is created to be an image of God. It is spiritual for it is able to know spiritual things. The soul is present, in its entirety in each of its parts;

[1] Siebeck: Geschichte der Psychologie, p. 398-400.
[2] Ueberweg: Hist of Phil., Vol. I, p. 354.
[3] Ueberweg: Hist. of Phil., Vol. I, p. 304.

it is everywhere present in the body and not limited by a spatial form.

Taking a general view of this early period, embracing the time of all the church fathers, Spencer notes:[1]

"The majority of the early fathers believed that the soul was corporeal. Amongst the pagan writers there was a progressive effort to conceive of the soul more purely; some made it a vapor, a breath, a fire. The same tendency existed among the Christians; 'still the idea of the materiality of the soul was more general among the Christian doctors from the first to the fifth century, than among the pagan philosophers.' It was against them that certain fathers maintained its materiality, so that it should be rewarded or punished after death. In Gaul—Faustus, Bishop of Riez, in the fifth century, maintained that God alone is incorporeal, and that the soul occupies a place, is enclosed in a body, quits the body at death, and re-enters it by the resurrection."

Scholasticism offered little in advance over what the Patristic fathers had set forth; on the whole was rather a relapse to former ideas. Controversies as to the details of a broader doctrine often occupied the best minds. Augustine's analyses and methods, the translation of Aristotle's metaphysics and a general survey of the Greek culture and philosophy, brought forward the problem of Being, initiated the controversy over universals, and evoked a discussion of the questions of nominalism and realism. These questions pertaining to the reality of the individual and the universe, all had their influence; this much was a fact, whatever and wherever reality exists, since the soul's abode hereafter is with God, there must be a similarity, in composition and nature, or whatever of his being exists in man; that constitutes the immortal part. Christianity in the earlier centuries was allied to the idealism of Plato; the return to Aristotle gave rise, during the mediæval period, to the opposed doctrines of nominalism and realism. This dispute can be traced back to fundamental ideas set forth by these philosophers.

Erigena, during the ninth century, taught[2] that everything living comes from something that has previously existed. The visible world is an emanation from God. The "soul of the world" of the Greeks is nature. The particular life of the individual is therefore a part of the general existence of the mundane soul. All things return to God, the soul of the "universal Intellect." The soul returns to its previous state. Sometimes the doctrine of Plato prevailed during the Middle

---

[1] Outlines of Sociology, No. VIII, p. 121.

[2] Draper: Conflict Between Science and Relig., p. 125-6.

Ages, and sometimes that of Aristotle. Bernard of Chartres, and William of Conches of the twelfth century were followers of Plato. The former[1] declared the world soul to be an entelechy which issued as if by emanation from the divine mind. This soul has given shape to nature. With Albert Magnus, Thomas Aquinas, Occam and Scotus of the thirteenth century a new era opens. Industrial and internal conditions of society were coming more into conformity with peace relations. The church was gradually losing its hold on society as a regulative force and signs of the Renaissance were being manifested.

Albert Magnus[2] thought "only that whose existence is self-derived has by its very nature eternal being; every creature is derived from nothing; and would therefore perish, if not upheld by the eternal essence of God. By virtue of its community with God, every human soul is an heir of immortality. The active intellect is a part of the soul, for in every man it is the form-giving principle, in which other individuals cannot share. This same thinking and form-giving principle bears in itself the forces, which Aristotle calls the vegetative, sensitive, appetitive, and motive faculties, and hence the latter are, like the former, capable of being separated from the body, and are immortal." The soul is the entelechy of the body, yet since certain of its functions are not connected with its organs, it is separate at these points, and at all points from the body. Man, in so far as he is man, is intellect; the highest stage of life is attained by knowledge, the participation in the divine. "With[3] the five senses and the *sensus communis* are said to be connected the *vis imaginative* and aestimativa, which are common to all animals; further, the *phantasia*, which at least the higher animals have; and finally the *memoria*." The *pars rationalis* of the soul is unchangeable, independent of matter, receptive; the intellect is the part of virtue of which man is immortal. This system so elaborately begun by Albert was completed in its different phases by Thomas Aquinas. The theological aspect was elaborately worked out by him. Both men are followers of Aristotle, the latter, it will be noted, sought to bring the teachings of Aristotle in closer *rapport* with the church.

For Thomas[4] the embryo, from the beginning of life, possesses a soul, but it is only a vegetative one. This soul disappears to make room for another; the second is both vegetative and sensitive, this yielding its place to a third, an intellectual soul, which includes the other two. It is a form without matter,

[1] Ueberweg. Hist. of Phil., Vol. I, p. 398.
[2] Ueberweg: Hist. of Phil., Vol. I, p. 398.
[3] Erdmann: Hist. of Phil., Vol. p. 406.
[4] Janet and Seailles: Hist. of the Problems of Phil., Vol. II, p. 195.

the entelechy of the body. The vegetable and sensitive souls are present in the embryo before the rational soul appears, this comes from without, is created immediately and fuses with the other two. All beings except God were created by God; the angels were the first and the noblest creatures and, like the angels, the souls of men are immortal forms. The rational soul has an existence apart from the body.

The vegetative and animal faculties depend only in their temporal activity on bodily organs. The intellect alone works without an organ, because the form of the organ would hinder the correct knowledge of other forms than himself. God and the active and passive human intellects are related to each other as are the sun, its light and the eye. The forms, which the passive intellect takes from the external world through the senses, are rendered really intelligible by the active intellect—there is no innate knowledge. The human soul does not have a pre-existence, but it does continue to live after death; is not destroyed by the dissolution of the body. Immortality belongs not merely to the thinking power, but also to the lower powers; the soul forms for itself after death a new body similar to its former one.

Thomas pointed out the distinction between the *anima sensitiva* and *anima intellectiva* in such a way as to harmonize the disputed points of Creativism and Traducianism. He regarded the *sensitiva* as a natural product while the *intellectiva* is a creation of God. The angels have the highest intelligences, the moving of the heavenly bodies is their first work. The *intellectus possibilis* is a part of the soul and is determined individually—it is the capacity of actively seizing the forms—and is immortal. The active understanding as well as the *intellectus possibilis* is a part of the soul and these two fill the whole body; if it were not so, man would not be responsible for his thoughts, which are the product of the *intellectus speculativus*, nor for his acts, which are products of the *intellectus practicus*. Memory does not survive death. The soul is an intelligence having form (substantial), and as such may survive the body. The existence of a soul in the bodiless form is contrary to its nature, so it becomes rehabilitated, the new body is called spiritual because it is subordinate to the soul; there may be bodily punishments after death.

With St. Thomas the philosophy of the Christian school, scholasticism, reaches its highest point. Weber[1] notes that scholasticism is first influenced by Platonism through the mediation of St. Augustine; from the thirteenth century on, it gradually suffers from the influence of Aristotle's philosophy.

---

[1] History of Philosophy, p. 202.

The latter period is further divided into one in which Aristotle is interpreted as a realist, and later as a nominalist. With the decline of scholasticism, theological discussion, as constituting the whole of philosophy, became less and less the dominant motive; the church no longer had a controlling influence. New interests and discoveries tended to dissipate thought, and offer new channels, aside from the purely theological view. These changes in the attitude of the people toward the church continued to grow with the development of scientific ideas, and on account of the fixed condition of affairs resulted finally in those disruptions of the church which have occurred from time to time since the mediæval period. Theological dogma established by the early fathers has changed little regarding the ideas of the soul, and St. Thomas, whose doctrines are still vital in the church, agrees very closely with Aristotle. Scholasticism practically came to a close with William of Occam; with the growth of science since that period, the views of life have constantly enlarged as discovery has progressed. New material and discovery have tended to limit the influence and work of the church and set it in its proper sphere. The doctrine of William of Occam may be summarized briefly as follows:

The [1]feeling soul (*anima sensitiva*) and the soul as form-giving principle (*forma corporis*), *i. e.*, the vegetable soul — of the body, are not identical with the thinking mind (*anima intellectiva*). The sensitive soul is extended, and is joined in a corporeal manner to the body, all parts of which it fills (circumscription), so that its parts dwell in separate parts of the same body. But the intellective soul is another substance, separable from the body and joined with it definitive, so that it is entirely present in every part. He argued for the separate substantial existence of the intellect, as founded on the antagonism between sense and reason.

A hasty glance at modern theological views will be taken, yet they do not reveal many new ideas. The Saracen view of the soul, as expressed by Al-Gazzali, is that "God has created the spirit of man out of a drop of his own light; its destiny is to return to him."

The question as to the origin of the soul has arisen from time to time. Another view in regard to this is: "As[2] life is given to the child in his mother's womb, so the angel pours the soul into him." — Friar Berthold. Sermon.

Luther expressed himself in favor of creationism. Later teachings of the Lutheran doctrine of the seventeenth century

[1] Ueberweg: Hist. of Phil., Vol. I, p. 464.
[2] Hagenbach: History of Doctrine, Vol. II, p. 241.

opposed the view. Modern teachers of the Protestant doctrine, *e. g.*, Göschel, recognized spirit and psyche, the latter being propagated by procreation, the former, by creation. Schöberlein regarded the soul as a natural product, but thought that the created spirit is absorbed into the soul of man, the two forming a union. Thus the soul becomes possessor of the spirit.

In regard to animal spirits and their relation to the soul: "These spirits are either the soul or an immediate instrument of the soul: this is certainly true; and their brightness surpasses the brightness of the sun and of all the stars. What is most wonderful is that in godly men the divine Spirit itself mingles with these same spirits, and with His divine light makes them still more bright, so that their knowledge of God may be yet more luminous, their attachment to Him more solid, and their aspirations toward Him more ardent. But if devils dwell in the heart, they blow upon the spirits, and bringing the heart and brain into confusion, interfere with judgment, give rise to open madness, and induce the heart and other members to commit the most cruel acts." — Melancthon.[1]

Relative of the soul to God and its nature: " . . . we are fashioned in the image of God in our minds or souls. . . . But what this image is we know not, excepting that the soul is the substance, upon which the image of God is specially impressed. And as we have never seen God in Himself, in His own form, we cannot know how our souls are like Him in substance and nature. And it comes at last to this, that the workings or powers of the soul, viz., will, understanding and memory, are nothing but signs of the essential image, which we shall really see when we see God as He is in Himself, and ourselves in Him." — Zwingli[2] Von der Klarheit des Wortes Gottes, I, 56.

St. Teresa uses language signifying some kind of animate substance and as though it were apart from the body: "The disquiet of the soul comes most frequently from bodily indisposition— for we are so wretched that this poor prisoner of a soul shares in the miseries of the body. The changes of the seasons and the alterations of the humors very often compel it, without any fault of its own, not to be what it would, but rather to suffer in every way,— some discretion must be used in order to understand whether ill-health be the occasion or not. The poor soul must not be stifled." — St. Teresa, Life, XI.

The spirit nature of man: man's spirit is his mind, which lives after death in complete human form. "Men are con-

---

[1] Lange: History of Materialism, Vol. I, p. 238.
[2] Hagenbach: History of Doctrine, Vol. III, p. 73.

stantly surrounded by spirits and angels of God who understand everything spiritually, because they are spiritual. After death, too, men are instructed by angels." — Swedenborg, Divine Revelation, I, p. 87.

The relation of body, soul and spirit: "The [1] soul is consequently, the sensitive organ, not the body, and is therefore the true and real body of the spirit, and the body is only its outward framework, its shell and covering." — Zschoke.

Soul and body: "Nature [2] is a living organism; there is an ideal in the real, a subject within the object, reason in matter. There is a soul in the world. All is pervaded by a law of polar forces." — Schelling.

Relation of God and man: The instances given below are taken from a number of more recent ideas, collected from the writings of different authors.

"The spirit is the spiritual nature of man as directed upward, and as capable of living intercourse with God. The soul is the spiritual nature as the quickening power of the body, as in animals; hence excitable through the senses, with faculties of perception and feeling." — Auberlen. Thompson's Dictionary of Phil., p. 36.

"The soul is the inferior part of our intellectual nature. The spirit is that part of our nature which tends to the purely rational, the lofty and divine." — Fleming. Vocab. of Philos., p. 474.

"Man was created psychical, but with the destination and means to become spiritual. The important point of his beginning lay in the soul, which unites his spirit-life and his corporeal life, by means of which, spirit and body stood in a reciprocal relation, whose aim was the glorification of the body." The life of the spirit was to make the soul — and by some means, the body the reflection of itself. "The soul, as little is the *doxa* of God, has an existence severed from its origin, and stiffened into passive, deliberate neutrality; the egress of the soul from the spirit is a continual process engaged in constant accomplishment, whose progress is only distinguished from the creative commencement by the fact that, after man is once created, both, without any temporal before and after, have an existence absolutely contemporary, and placed under a similar law of development." — Delitzsch: A System of Biblical Psychology.

"Our soul, [3] properly speaking, is not ours but we are its. It is not a part of us but we are a part of it. It is larger than

[1] Hemstreet: Mind is Matter (quoted), p. 37.
[2] *Ibid.*, p. 52.
[3] Ways of the Spirit, pp. 358-62.

we are, and older than we are, — that is than our conscious self. . . . It is not aboriginal, but a product, as it were the blossoming of an individuality. We may suppose countless souls which never bear this product, which never blossom into self. And the soul which does so blossom exists before the blossom unfolds." Whether a new soul is furnished to each new body, or whether the body is given to a pre-existing soul — psychology seems to favor the latter. "What we call 'I' is not the origin, but a product of the soul, a phase or mode of its present life. The soul was prior to its conscious self; it is the root or seed from which the conscious self has grown."—Hedge. The spirit[1] is the higher side of our incorporeal nature—the mind, as it is termed in scripture, when contemplated under its intellectual aspects, — the inner man, as it is also denoted, when viewed in its purely theological relations, in a word, the moving, ruling and animating principle of our natures. It is also the medium of our communication with, and the very temple of, the Holy Ghost. Thus the spirit may be regarded more as the realm of intellectual forces. . . . The soul is the lower side of our incorporeal nature, and the subject of the spirit's sway. It may be regarded more as the region of the feelings, affections, and impulses, of all that peculiarly individualizes and personifies. But it should be observed that scripture often represents the soul to us as almost necessarily involving and including the spirit. Thus the scripture never speaks of the salvation of the spirit, but the salvation of the soul."—Ellicott.

"It is [2] this trial of the soul which shows that one is never alone in the universe. It is the supreme evidence that there is a God, the one unquestionable assurance that God means something in all that we endure and suffer."

"If we are all ultimate manifestations of one Infinite Life, then in deepest truth, there is but one soul. . . . It is the consecrated person who has the greatest evidence that there is a soul . . . because he can thus transcend the limitations alike of feeling and thought, of time and space, is the ultimate reason for saying that man has, yes, that man is, a soul." — Dresser.

"I see [3] no scientific reason for doubting that disembodied spirits affect man both for good and for evil as men affect one another." — Dr. Lyman Abbott.

[4] "The individual existence of man begins on the sense plane of the physical world, but rises through successive gradations

---

[1] Destiny of the Creature, pp. 120-24.
[2] In Search of a Soul, pp. 76-87.
[3] Quoted by Hemstreet: The Substance of the Soul, pp. 180-84.
[4] In Tune with the Infinite, p. 29.

of ethereal and celestial spheres, corresponding with his ever-unfolding deific life and powers, to a destiny of unspeakable grandeur and glory. Within and above every physical planet is a corresponding ethereal organism, or soul-body, of which the physical is but the external counterpart and materialized expression. From this etherealized or soul-planet, which is the immediate home of our arisen humanity, there rises or deepens in infinite gradations, spheres within and above spheres, to celestial heights of spiritualized existence utterly inconceivable to the sense of man. Embodiment, accordingly, is two-fold,—the physical being but the temporary husk, so to speak, in and by which the real and permanent ethereal organism is individualized and perfected, somewhat as the full corn in the ear is reached by means of its husk, for which there is no further use. By means of the indestructible ethereal body and the corresponding ethereal spheres of environment with the social life and relations in the spheres, the individual and personal life is preserved forever."—Trine.

The ideas of soul, expressed in the teachings of Christian Science,[1] are to the effect that Mind, Soul, Spirit and God are alike in substance. "Soul or Mind is not seen by a corporeal sense, because it is spirit, which physical sight cannot discern. There is neither growth, maturity, nor decay in Soul. These errors are the mutations of sense, the varying clouds of mortal belief, which hide the Truth of Being."

"Science reveals Soul as God, untouched by sin and death, as the central Life and Intelligence, around which circle harmoniously all things in the systems of Mind."

"Spirit is the only Substance, the invisible and indivisible God. . . . There is but one Spirit, because there can be but one Infinite, and therefore but one God."

"Soul and Spirit are one. God is Soul. Therefore there can be but one Soul. Soul is not corporeal; neither does it belong to a limited mind or a limited body."

"The term souls, or spirits, is as improper as the term gods. Soul, or Spirit, signifies Deity, and nothing else."

"The immortality of Soul makes man immortal. If God, who is the Soul of man, were parted from His reflection, man, during that moment, etc. . . . Science reveals Spirit, Soul, as not in the body, and God as not in man, but as reflected by man."

"Human thought has adulterated the meaning of the word soul. . . . The proper use of the word soul can always be gained by substituting the word *God*, where the deific meaning is required. In other cases, use the word *sense* and you have

[1] Science and Health, pp. 206-235.

the Scientific signification. As used in Christian Science, Soul is properly the synonym of God, or Spirit; but out of Science soul is identical with sense."—Eddy.

"I gather this—that the spiritual body is real, is tangible, is visible, is human, — but that we shall be changed." — Eliz. Stuart Phelps: Gates Ajar.

"The spirit of the departed dead, I am convinced, have a certain influence over our minds" — Bishop Bowman.

"Radiant forces pass from us continually, as truly as light proceeds from the stars. A speaker reaches his audience by invisible ways that penetrate to the interior sense." — Denton.

"The mind is a spiritual substance, and there goes from it a sphere that surrounds it, and it is a radiant force like light or heat." — Evans.

The ideas presented in the latter part of this section are self-explanatory.

The opinions, either directly or indirectly expressed, of thirty-eight persons have been briefly presented. These give us, to some extent, a chronological view of various notions of the soul that have been held at different times by persons identified with the church, or those presenting the subject from a theological standpoint. The rules and laws of the church, as guides to certain beliefs or as forces compelling certain beliefs, must not be overlooked. In this respect we have a standard set up, — in one sense a school for education along certain lines, for those who are to become its members. The standards have changed from time to time, and have been revised by various church councils. Certain doctrines have been condemned at times; for instance, the Platonic idea of pre-existence was carried along through Neo-platonism, and came in contact with the doctrines of the church. Origen, among others, had taught it, but at the second council at Constantinople (553) Origen's teachings were condemned because they were thought to be too free and unsystematized, and with them the doctrine of pre-existence. This blow of the church was also aimed at Neo-platonism. The much disputed point of trans-substantiation, which was satisfactorily settled at the Synod of Vienna, has been a potent factor in volatilizing thought, *i. e.*, the bread and wine symbolized Christ's body; finally they came to represent life in Him.

Another factor[1] that has been potent in forming the idea of the soul is that of angels. Ideas suggested by their pictures and descriptions have had great influence in shaping ideas in regard to the soul. Justin Martyr regarded angels as personal beings who possess a permanent existence. He thought their

[1] Hagenback: Hist. of Doct., Vol. I, pp. 193-98.

bodies are analogous to those of men, and their food manna.

Tatian thought their bodies ethereal and claimed that they could be perceived only by those in whom the spirit of God dwells and not by the natural or psychical man. Clement, in describing them, observed that they have neither ears, nor tongues, nor lips, nor entrails, nor organs of respiration, etc. Origen assigned to each a sphere of work.

In the Middle Ages[1] the science of spirits (souls) was called Pneumatology. It comprised the study of God, angels and man, the psychology of angels holding a place side by side with that of man.

During the later scholastic period[2] angels are distinguished from the souls of men as follows: (1) Physically, they have no actual need of a body. (2) Logically, they do not obtain knowledge by inferences. (3) Metaphysically, they do not think by means of images, but by immediate intuition. (4) Theologically, they do not become better or worse.

The nature of angels afforded much ground for debate. The ideas still prevalent are potent factors in moulding the lives of young people.

Much of the discussion concerning the soul during the past, as gathered from this study, has been without fact as a basis. A larger entity, nous, world-soul, spiritual existence, etc., is believed in; this, it is supposed by many, resides apart, has a personal relation to man, has furnished him a soul, presides over him in a personal manner. At death, if the soul is still in harmony with its creator, without sin, it returns thither. Early Christians thought that with the advent of Christ something had been done for them, that some objective help had been extended to them. This view still holds with some. The doctrine of immanence as a result of pantheism has tended to modify this view In this Spinoza has been influential. Later thought, in many instances, recognizes the existence of a universal pervading spirit; soul is related to this from above; from below it has its corporeal relations with its fellow creatures. Most of the views presented belong to those who have been leaders at some time and do not represent the laity. Modern thought tends toward an ethical interpretation of the soul, this, perhaps, being the nearest approach to immaterial objectification that can be made.

The Soul with Reference to Systems of Philosophy.

Strictly speaking there may be no purely philosophical conception of the soul apart from theology, or from psychological

---

[1] Janet & Seailles: History of the Problems of Philosophy, Vol. I, p. 27.

[2] Hagenback: History of Doctrine, Vol. II, p. 235.

analysis. This separation is merely arbitrary. Yet there is almost as much basis for it as there is for a line of distinction marking off theology, philosophy and psychology as independent departments of knowledge, none of which are sharply defined. The justification for such a study is as follows: first we have the idea of the soul as it is related to a personal God, this being the view held by the church. Besides this we have various discussions of an entified soul in different relations to an absolute being, — this may be a pantheistic view, or represent the soul's relation to a world soul, or a spiritual world, or some form of the Absolute. Then we have the idea of the soul as derived from a study of mental phenomena, — rather from empirical data; this falling under the head of psychology. The philosophy of the Christian Era was under the domination of the church. "Unity, servitude, freedom, — these are the three stages through which it has passed in its relation to ecclesiastical theology," says Ueberweg.[1] "The first movement in this direction consisted in a mere exchange of authorities, or in the reproduction of other ancient systems than that of Aristotle, without such modification and such adaptation to new and changed conditions, as the scholastics had effected in the system of Aristotle. Then followed the era of independent investigation in the realm of nature, and finally, also, in the realm of mind. . . . The second epoch of Empiricism and dogmatism was characterized by methodical investigations and comprehensive systems, which are based on the confident belief that the knowledge of natural and spiritual reality was independently attainable by means of experience or thought alone. Skepticism prepared the way for the third stadium in the history of modern philosophy, which was founded by criticism." Independent thought, free from the influence of the church and schools of scholasticism, — "two prisons of [2] knowledge," began to find expression during the fourteenth century. From this period to the close of the sixteenth the awakening took place, followed by the Reformation. The various causes that gave rise to those changes cannot be noted here, they were fundamental, the growth was natural. The church gradually lost its influence along several lines: it could no longer say what a man should think, nor was it able to suppress the expression of thought; it had no control over the discoveries and inventions of the times, it could not keep pace with them nor incorporate them into its system. With such an outline as is here presented our philosophical consideration of the soul will begin with the period of freedom of thought. Since during

[1] A History of Philos., Vol. II, p. 2.
[2] Fischer: A History of Mod. Phil., p. 80.

this period we have also the beginnings in a generalized way of modern psychology, though it is subordinate to philosophy, the problem becomes more complicated. The central point in the[1] study of both was the nature of the soul.

Free philosophical expression began with no one man in particular, but is the result of the utterances of many teachers and writers. These philosophical expressions mark the beginning of modern philosophy. Different writers have ascribed to different men the beginning of this epoch. Lewes begins with Bacon and Descartes, Falckenberg with Descartes, etc. Bacon was a philosopher and scientist combined. He excluded theology from his scheme; — he says, "If I[2] proceed to treat of it, I shall step out of the bark of human reason, and enter into the ship of the church; which is only able by the Divine Compass to rightly direct its course."

The sensible soul of man is material like that of animals. It consists of a fine fiery air which streams from the brain through the nerves and is nourished by the blood. Sensibility of impressions is characteristic of everything. The sensible soul is material, the spiritual soul is implanted by God; only religion can give instruction pertaining to the soul.

As is God so also is the spirit, which God has breathed into man, scientifically incognizable; only the physical soul, which is a thin, warm, material substance, is an object of scientific knowledge.

Bruno was the first metaphysician of the sixteenth century to accept the heliocentric system. For him[3] the elementary parts of all that exist are the minima or monads, which are spherical points both psychical and material. The soul is a monad. It is never entirely without a body. God is the supreme monad. He is the minimum, because all things are external to him, and the maximum since all things are in Him. He is present in things in like manner as being is present, or beauty in beautiful objects. God is the original and immanent cause of the universe. The stars are moved by the souls immanent in them. Matter and form are identical; matter contains in herself the forms of things. The beginnings of science greatly influenced the philosophical systems during this early period.

The awakening to a knowledge of natural forces and their application led to extreme materialistic views. Cause and effect was sought for, mechanics used; as a result we have Hobbes's application of the laws of mechanics to mental phenomena, and the mechanical theory of Descartes.

For Campanella the inner sense is a proof that sensation is

[1] Bowne: Metaphysics, p. 299-300.
[2] Lewes: Hist. of Phil., Vol. II, p. 116.
[3] Ueberweg: Hist. of Phil., Vol. II, p. 27.

true, *i. e.*, that the object really exists outside of the individual. Sense-perception derives its character of certitude from reason and reason transforms it into knowledge. The inner sense reveals to me my existence immediately as a being that exists, acts, knows, and wills. To exist means to proceed from a principle and to return to it. Power, wisdom and love are the 'primalities' of relative being, the sum of these is God. By mingling non-being in increasing measure with His pure being, the Deity produced in succession the ideas, angels, the immortal souls of men, space and the world of perishable things. All these existences have souls; nothing exists without sensation. When plants wilt they grieve, after a refreshing rain they experience pleasure. Sympathy and antipathy account for the free movements of all natural objects. "The soul is corporeal;[1] it is the warm, mobile, nervous spirit. Things work upon this spirit, thereby assimilating it to themselves." The change that this produces remains in the spirit like a scar. It strives after its principle, not like most things after finite principles, but infinite. It attains immortality by virtue of its striving. As a philosopher Descartes with his "thought" as the essence of the mind or soul, later followed by Spinoza with the belief that the soul is the "idea" of the body, these in their wider sense no doubt are philosophical doctrines; but as analytical studies of soul they are considered under the section on psychology.

Gassendi revived the atomistic conception of the universe. The universe is a co-ordinate whole, the elements of which are atoms. These are determinations of an indestructible principle, which is matter. The appearance and disappearance of things is only the reunion and separation of atoms. He thought that atoms[2] possess feeling, they are created by God. An all-pervading world-soul is thus assumed. He attempted to unite spiritualistic ideas with atomistic and mechanic doctrines. The soul moves the body in so far only as it is itself material. There is a natural soul, vegetative-sensitiven (Lebens princip) and a rational, immaterial, immortal soul. These are connected. There are no innate ideas; all knowledge begins with the senses, they yield us immediate cognition of things; phantasy reproduces our ideas and understanding compares them. "Phantasia" is the counterpart of sense, it has to do with material images, it is material, and the same in both men and brutes. The intellect is immaterial and immortal; it attains notions and truths of which no effort of sensation or imagina-

[1] Pünger: A Hist. of the Christ. Phil. of Relig., p. 102.

[2] Carus: Lehrbuch der Psychologie, p. 193.

tion can give us the slightest apprehension: as the notion of God, for example. The final end of life is happiness, harmony of soul and body.

Leibnitz is one of the foremost among the philosophers belonging to this early period. Descartes recognized no extension in the soul, this was directly contradicted by Leibnitz's theory of monads. Our inner experience[1] reveals to us an active real force, which is the only force we know; this is our soul. Metaphysical atoms must be conceived of after the image of our soul. Everything in the world is force, soul, life, thought, desire; we see only the outside of Being, Being is that which itself sees. Perception explains the unity, likewise the diversity of the monads. The monad is a created thing and subject to change, its nature is perception. The effort made by a monad to pass from one internal state to another is appetition. The primitive monad is God; those which are thinking beings, like human souls, are capable of clear and distinct ideas; they are also conscious of themselves and of God. The souls of animals have sensation and memory.

"The merely living thing is the monad joined to an appropriate body. Its perception is unconscious and both perish together. *Omne corpus mens est momentanea.* The second degree is that of the monad endowed with more distinct perception, *i. e.*, with feeling; such a monad may be called a soul; when united to its proper body it is an animal. The third degree is that of the soul endowed with reason and reflection, or minds (spirits). The spirits are characterized by knowledge, properly so-called, by self-knowledge, by the possession of universal truths, and consequently the possibility of demonstrative knowledge." All the monads of the human body are independent, yet they harmonize with the monad soul. That which appears to us as a body is in reality an aggregation of many monads. Everything in nature is organized. There are no bodies without souls, also no souls without bodies. Plants and minerals are, as it were, sleeping monads with unconscious ideas. Every organism is a complex of them. In plants ideas are formative vital forces. The greater distinctness of its ideas distinguish the dominant monad, it is more active and more perfect, it reflects clearly while the body monads reflect but obscurely. The monads of the body are the first and direct object of the soul. The soul and the body of man agree, like two clocks originally set together and moving at exactly the same rate. When soul and body were first created, independent harmonious law was established. The soul following the law of association of ideas may have a painful sensation at the

---

[1] Leibnitz, by Theodore Merz, p. 177 *seq.*

same time that the body receives a wound. A desire arises in the soul and by the law of mechanics at the same instant the arm is extended.

"The more we think of it," says Bowen, "the more that doctrine of Leibnitz,[1] which appears so wild and fanciful at first, that every monad has in it from its first creation an infinite number of confused unconscious perceptions; and that these, in the successive stages of its being, are slowly evolved from each other in regular order, and so rise into consciousness, not through any contact or impulse from things without, though such contact or impulse furnishes the *occasion* on which they rise, but only through the monad's or soul's own internal law of development — the more, I say, this doctrine appears plausible and credible."

Voltaire presents quite a different view. The optimism of Leibnitz finds no place for him.[2] From the facts of astronomy he came to the conclusion that the teachings of the church were untrue. He may be taken as a representative of the scepticism of the French enlightenment; he emphasizes more strongly than Locke the possibility of the supposition that matter may think; and will not believe that there dwells within the brain an unextended substance, like a little God. He is inclined to regard the substantial soul as an "*abstraction réalisée*," like the ancient goddess Memoria, or such as a personification of the blood-forming force would be. All our ideas arise from the senses. "No one," says Voltaire, "will ever make me believe that I am always thinking, and I am no more disposed than Locke to imagine that several weeks after my conception I was a very learned soul, knowing then a thousand things which I forgot at my birth." He admits that certain ideas — moral, especially, although not necessarily innate, arise perforce from the constitution of human nature. He believes that the existence of God is demonstrable. The Deity and immortality are postulates of the moral feeling.

Voltaire, for example, expresses nothing positive. He is rather a representative of a reactionary movement of thought against church doctrine. The doctrine of innate ideas has been a burning question at times. The Innate Idea seems to carry with it something of the pre-existent, in fact it has been held in the past as a necessary support to religious teachings. Beginning with Plato, the theory did not meet with great opposition until the time of Locke.

The three ideas of innateness[3] are, (1) the idea is given us at our first creation, bearing no relation to the other faculties;

---

[1] Modern Philosophy, p. 45.
[2] Ueberweg: Hist. of Phil., Vol. II, p. 124.
[3] Fleming: Vocab. of Phil., p. 26.

(2) it is given us as a form, either of thought generally or of some particular species of thought, and is embodied in our mental powers; (3) the idea is interwoven in the original constitution of some mental power. The first view is that regarded by the church. Whether man came into existence with a trace from the past, or with a soul partly preformed, was a vital question, and since the time of Locke we find first one view predominant and then the other advocated, according as some one school or another came into prominence. In recent times the question is wrapped up in that of heredity.

Berkeley recognized only spirits and their functions; the existence of the material world is not only undemonstrable, but false. Abstract matter is a phrase without meaning; individual things are collections of ideas in us; if we take away all sense-qualities from a thing nothing remains. Ideas are the only objects of knowledge, nothing exists except minds and their ideas. His theory of mind is that ideas are of three sources.[1]

1. "Ideas actually imprinted on the senses.

2. "Ideas arrived at by attending to the passions and operations of the mind, as pleasure, pain, etc.

3. "Ideas formed by memory or imagination reviving and combining the two other classes." Besides these three kinds of ideas there is something that knows or perceives them and exercises the functions of willing, imagining, remembering. "This is mind, spirit, soul, myself, but it is something different from the ideas that constitute knowledge. All things that compose the frame of the world — subsist either in the mind of created spirits or in the mind of some eternal spirit. There is no other substance but spirit.

"Sense[2] and experience acquaint us with the course and analogy of appearances or natural effects. Thought, reason, intellect, introduce us into the knowledge of their causes." Sense implies an impression from some other being, and denotes a dependence in the soul which hath it. Sense is a passion; and passions imply imperfection. God knoweth all things as pure mind or intellect; but nothing of sense, nor in, nor through a sensory. As men rise from the life of sense toward the reason that is found to shine in and through sense, they approach that union with God — the chief end of man Each lower faculty in us is a step that leads to one above it, — the uppermost brings us to God, who is Reason. Ideas are not innate but the rational constitution of things is innate in that intellect which we share with God. The existence of matter is

[1] Bain: Mental Science, p. 203.

[2] Fraser's Berkeley, pp. 203-206.

not directly known, the existence of spirit is known directly. This is the only existence. The natural or created ideas which God impresses on us are copies of the eternal ideas which he himself perceives through his creative reason. Thus, following Berkeley's views, we do not arrive at any definition of soul, but mind or spirit is the only real existence. God exists as a spirit, and man's nature partakes of this spirit life.

Reid, the founder of the Scottish school, propounded a system of philosophy in which appeal was made to common sense — this in order to avoid the scepticism of Hume.

"I take[1] it for granted that all the thoughts that I am conscious of or remember, are the thoughts of one and the same thinking principle, which I call *myself* or *my mind*." "Every action or operation therefore supposes an agent; every quality supposes a subject. . . . We do not give the name of mind to thought, reason, or desire, but to that being which thinks, which reasons, which desires." "My personal identity implies the continued existence of that indivisible thing which I call myself. To what purpose is it for philosophy to decide against common sense. The belief in a material world is older and of more authority than the principles of authority." To judge of first principles requires no more than a sound mind free from prejudice, and a distinct conception of the question. Those things really persist that we distinctly perceive by our senses, and are what we perceive them to be. The qualities that are perceived by the senses must have a subject (*i. e.*, the body), the thoughts we are conscious of must have a subject (*i. e.*, the mind). The distinction between sensible qualities and the substance to which they belong is found in the structure of all languages. Nothing is more absurd than that there should be extension without anything extended, motion without anything moved. Every sensation is the sign of the presence of an object. The reality of the subject is guaranteed by thinking. What the understanding recognizes clearly and distinctly is necessarily so. We perceive because God has given us the power of perceiving. The sphere of consciousness cannot be transcended. Reid's view, as the common sense one, identifies the mind or soul with that which thinks, reasons and desires; one's personal identity implies the continued existence of an indivisible self.

Lessing is regarded by some as a follower of Leibnitz. For Lessing the Deity is the "supreme, all-comprehensive living unity, without life and action and the experience of changing states. Things are not out of God but in him, yet distinct. God's thinking is creation, his ideas actuality. Every individ-

---

[1] On the Intellectual Powers of Man, Vol. I, chap. xi.

ual is an isolated divine perfection. Things in the world are all living, all have souls and of a spiritual nature, though in different degrees, in fact they are limited gods. Development is everywhere. The soul now has five senses but probably it once had less than five and in the future will have more. God creates only simple beings, there exists a harmony among these that explains all the world processes. With different degrees of perfection these beings possess different degrees of the consciousness of this perfection and act accordingly. All created things are simple percipient beings. God is the highest and most perfect monad. Harmony binds the world and all that is in it together. Soul [1] is a simple being which is capable of infinite perceptions; as a finite being it is not capable of this at once but gradually in an infinite succession of time. Thus it becomes developed, but it implies a future life. We may receive more senses in that life, a new organization, as we develop, that we may receive more ideas. The material world is animated, particles serving the soul in any one sense constitute homogeneous combinations of matter; there may be as many senses as there are such possible combinations; there are more than five of these. The individual soul has already been several times in different bodies and shall continue to develop through similar transmigrations in the future.

According to histories of philosophy this might be the place in a series of briefs like these to mention Kant, and in fact classic philosophy would almost consider it a sacrilege to omit some treatment of his ideas. Perhaps this is the place, yet this study pretends to be historical only in the sense of getting a general picture, and mention is made elsewhere of his ideas. He examined critically the rational and empirical views that have been held by the different schools, pointed out inconsistencies, and, as far as possible, attempted to harmonize them. In place of the antitheses which Kant had set up between the categories as rules of the understanding and principles of the reason, Fichte regarded these as strata; that is, the reason apprehends in a purer form what it has accomplished in a lower stage. Fichte thus develops one part of the Kantian system more completely, — instead of the transcendental being closed we develop into it. Philosophy is "the systematic development of the idea of the Ego." [2] The non-Ego is a postulate of our reason, — this is, at the time, unconsciously made, it is a product of the Ego The Ego alone remains when the unknown (substance) is abolished. The Ego creates this. Starting from the existence of mind or ego, Fichte developed his

[1] Pünjer: Hist of the Christ. Phil. of Relig., p. 568.
[2] Adamson's Fichte, pp. 163-188.

system. The absolute Ego is known by an intellectual intuition. The first and lowest stage of the Ego is one of passivity, it is not reflectively aware of the activity involved in itself, but rather a state of sensation. The second stage is reached when it is aware of the activity in itself, of sensation; when it reflects on these, and opposes to itself something foreign, this is the stage of intuition. By reflection on intuition an image of that which is considered constructed, this image is distinguished from a real thing to which the image corresponds, forms the third stage. A fourth is understanding through which the concept is gained; the fifth and highest stage of the consciousness is reflection upon judgment, in this abstraction is made of all save the Ego itself, which is pure abstraction.

The only reality is the spiritual, matter as non-Ego is postulated, the mind makes all that it knows. The absolute Ego, the universal soul, whose essence is activity, sets opposite to itself an illusory world. Fichte's notions of philosophy were modified in later years, the idea of a personal God was criticised. In his later works God is the moral order of the world. The life of consciousness, the manifestation of God, breaks itself up into an endless multiplicity of individual forms; these, as independent, self-existing facts, are the mode of one infinite life.

"The substance[1] is the totality of its accidents, nothing more is embraced in it than the accidents; analyze the substance, and nothing is reached but accidents. An enduring substance, or, if you please, a bearer of accidents, is not to be thought of; one accident supports another. . . . The soul is no more than nature; it is a phenomenon of the internal sense. But we must frame a better notion of nature than that it is a dead material thing; we must think of it as spiritual. Nature is a formal image of the absolute, and its supreme point is man." Soul becomes the active principle, creating nature.

Fichte's system of idealism is followed by Schelling, and this again by Hegel. For Fichte[2] it is the "I" that exists, for Schelling the "I" and the object are both real, for Hegel the only thing really existing is the idea. In order to explain the development of nature from the lowest to the highest formations, Schelling assumes the existence of a soul of the world as an organizing principle. The perfect theory of nature would resolve all nature into intelligence. Dead and unconscious products of nature are abortive attempts to reflect itself, it is immature intelligences which shines through all her phenomena. All individual intelligence may be regarded as integral parts of God, or of the moral order of the world. Matter is extinct

---

[1] J. G. Fichte: Werke, Vol. II, p. 562 *seq.*
[2] Lewes: Hist. of Phil., Vol. II, p. 595.

mind. The eternal Son of God is the finite as it exists in the eternal intuition of God. This Finite appears as a suffering God, — subject to the fatalities of time. History mirrors the world-spirit as an eternal poem of the divine understanding. Nature is the embryonic life of spirit, they are essentially identical. The real and the ideal, the objective and the subjective are, so to speak, two poles of the Absolute. This world-soul embracing subject and object is apprehended by us in our deepest intellectual intuitions. The plurality of souls is the development of the Absolute.

"My Ego[1] is only so far, and can be thought of only so far as it thinks itself." It brings itself forth by its thinking, — by absolute causality.

"The Ego or human spirit abstracted from its powers and acts is nothing. The soul is not something existing in itself, and which could consequently exist, if it neither felt, nor thought, nor willed."

"The soul, as it exists by relative antithesis to the body, consequently not in itself, appears only by this antithesis as determined to existence. It is on the one side, one with the body, and on the other, it is the infinite cognizing. To the soul so far as it is finite, we must ascribe all the relations which are of necessity ascribed to the body. In its infinite cognizing, the infinite thinking has become objective; on this being, at once subjective and objective, infinite and finite, rests the Ego. It is the unity of the subjective and objective." There is no such thing as body opposed to soul. We give the name of spirit to the power which, in its being exterior to itself, still abides with itself.

Hegel represents another type of idealism. The attempts of idealists to define God and the soul and to establish a relationship between them have been the chief factors reducing these elements to unknowable or unthinkable terms. For Hegel[2] all things come from the Absolute, which is the idea. Spirit is developed, by the logical process, from dependence on nature to freedom, this is its essence. The steps of progress are the subjective spirit depending on nature and on the body, this is manifest in the study of anthropology; the objective spirit seen in the products of the will: customs, laws, etc.; and the absolute spirit which appears in art, religion, and philosophy. Reality is the common source of the Ego and nature, they are immanent in it. Mind and nature are the successive modes of God, and the union of nature and idea is in spirit, is in God. The soul is not present at any one point, but everywhere at

---

[1] Fleming: Vocab. of Phil., Fichte, Werke Vol. I, p. 96; II, 193-95.
[2] Ueberweg: Hist. of Phil., Vol. II, p. 233.

millions of points. "The principle[1] stages of subjective spirit are natural spirit, or soul, consciousness, and spirit as such." The momenta of the Idea are life, cognition, and the absolute Idea; the Absolute Idea is the pure form of the conception. Nature is the idea in the form of otherness. "The death of mere immediate, particular life is the birth of the spirit." Psychology considers spirit as intelligence, will, and ethicality.

The divine and the human are one, man's spirit is identical with the infinite intelligence. "We must say of everything which exists, that it exists and is maintained by an eternal act of knowledge on the part of the Absolute; and the spirit of man, being itself the Absolute, has the faculty of reproducing freely, through speculative thought, this eternal act of knowledge."

"The pure[2] reference to myself—the reflection in which I no longer refer myself to some other, but refer myself to myself, or an object to myself—this is the Ego, the web of the infinite being itself. It is the complete abstraction from all that is finite. The Ego as such has no contents given by nature or immediate, but has only itself as contents, as it is only by means of abstraction from every other. This pure form is at the same time its contents." The body is the same life as the soul, and yet they may be spoken of as lying asunder. A soul without body would be nothing living, and the converse is true. The existence of the notion is its body; the body obeys the soul which has brought it forth. The germs have the true in them, and embrace its total force, though they are not yet the true itself." "The soul generates the unity of the body and is its permeating vital force." This indicates very briefly the pantheistic view of Hegel. Yet for as complete system as he has given it can be but a very brief account.

Briefly passing over some of the more recent ideas we note the following: For Hamilton, "Subject denotes the mind itself, mind and matter as known and knowable are only two different series of phenomena or qualities; as unknown and unknowable they are the two substances in which these two different series of phenomena or qualities are supposed to inhere. The existence of an unknown substance is an inference we are compelled to make from the existence of known phenomena. God is an object of faith, not knowledge, "a God understood would be no God at all." Through experience and reason we are naturally inspired with a kind of suggestion and belief in being, transcending what we actually experience. Experience, especially of mind, is the ground for deciding alternatives in

---

[1] Caird's Hegel, p. 183.

[2] Werke XVIII, 21 and 93; VIII, 22, 23. Fleming's Vocab.

theology. On the ground of experience and what we find in consciousness only can we have any convictions regarding the nature of mind, the world, and of God. The substance of the mind and the world are incognizable *per se*, but relatively knowable through special qualities and manifestations. Mind is known primarily as Ego or self in its unity amid successive stages. By analogy from our experience we reach a noumenal entity called God, related on the side of time and space to the things therein, on the side of mind to the Ego and the contents of consciousness. These relations give us an imperfect knowledge of God. There is no need for a doctrine of omnipresent creation, the grand order of the cosmos may have been constituted in one great act. "Consciousness[1] is simple — is not composed of parts, either similar or dissimilar. It always resembles itself, differing only in the degree of its intensity: thus there are not various kinds of consciousness, although there are various kinds of mental modes or states of which we are conscious."

For Schopenhauer.[2] The unconscious will which constitutes the reality of things existent, is first and original. The intellect is physically conditioned, depending on the functioning of a material organ. It is dependent upon this organ and without it is just as impossible as the grasp without the hand; it belongs to the phenomenon. Will is bound to no special organ, is everywhere present, that which moves and forms, and conditions the whole organism,—the metaphysical substratum of all phenomena. Death teaches man that his true nature which is will, will henceforth live in other individuals, while his intellect continues to exist in the condition of being idea, *i. e.*, in the objective being of things.

"It is purely impossible for us to be conscious of ourselves, independently of the objects of knowing and willing. When we enter into ourselves, and begin to reflect on ourselves, we lose ourselves in a fathomless emptiness, in a darkness in which all cognition ceases, and we grasp nothing but an insubstantial spectre, the Ego itself remains after it all a riddle."

For Fechner: The soul of man partakes of the larger consciousness animating the world. The earth-soul looks through the eyes of all men. As our body is occupied throughout by our soul, so the world-soul or God occupies the universe.

"The phenomena[3] of body and soul hang together as internal and external phenomena of the same essence. This primary essence is, however, nothing more than the conjunction of phe-

---

[1] Hamilton's Metaphysics, LXI.
[2] The World as Will and Idea, Vol. III, pp. 3 and 306; I, 327.
[3] Physical and Philosophical "Atomlehre," pp. 258-59.

nomena themselves in the unity of a general consciousness. The soul becomes aware only of its own proper phenomena, the body becomes aware only through that which appears of it to the soul itself. It is a common essence which appears externally as body, internally as soul."

"The entire[1] spiritual life is rooted in this corporeal soil, and uses the bodily organism as its instrument. The spirit has no independent agency; it acts only through and in the body. It can manifest itself only by means of its necessary instrument, the body. Hence every disturbance of the body will produce, by reaction, a corresponding disturbance in the mode in which the mind is accustomed to manifest itself." — Luthardt.

For Spencer:[2] "Mind as known to the possessor of it, is a circumscribed aggregate of activities; and the cohesion of these activities, one with another, throughout the aggregate, compels the postulation of a something of which they are the activities. But the same experiences which make him aware of this coherent aggregate of mental activities, simultaneously make him aware of activities that are not included in it. . . . These external activities must forever remain to him nothing more than the unknown correlatives of their effects on the aggregate." Mind and matter are alike unknown.

"Once more we are brought round to the conclusion repeatedly reached by other routes, that behind all manifestions, inner and outer, there is a Power manifested. Here, as before, it has become clear that while the nature of this Power cannot be known — while we lack the faculty of framing even the dimmest conception of it, yet its universal presence is the absolute without which there can be no relative facts. Every feeling and thought being but transitory — an entire life made up of such feelings and thoughts being also but transitory — nay, the objects amid which life is passed, though less transitory, being severally in course of losing their individualities, quickly or slowly: we may learn that the one thing permanent is the Unknowable Reality hidden under all these changing shapes."[3]

"In the organism formed of atoms, which are spiritual essences, one unfolds its spiritual force to the point of self-consciousness; this atom, which as gasiform atom interpenetrates the entire organism, and occupies space as a centre, is the soul. It is invisible, but a local and not unphysical essence. The mass of the brain is an organized state of living essences, which are directed by one of their own number in the midst as a choir of music by their leader." — Drossbach. Harmonie der Ergebnisse der Naturforschung.

[1] Fundamental Truths, p. 125.
[2] Prin. of Psychology, Vol. I, pp. 159-160.
[3] Principles of Psychol., Vol. II, p. 503.

"The [1] chief evidence of the soul's spirituality will be found to be, when inspected, intuition. . . . All the attributes of matter are absolutely irrelevant to spirit and to all of its modifications." . . . Ideas are impressed in it. "It is a substance that is simple monadic, indivisible, unextended and devoid of sensible attributes."—Dabney.

"The reality [2] of the soul consists in its ability to act; other reality it has none. How the soul can act there is no telling. In thinking of the soul we must not look for a lump, nor for a category, nor for a picture, but for the agent which thinks and feels and wills, and knows itself in so doing. And this soul is neither in the heights nor in the depths; it is very nigh indeed, for it is simply the living self."

"The self-identification of the soul, then, is the best proof of identity, for identity has no other meaning." — Bowne.

As a constant [3] there is no immaterial soul substance; the existence of the soul consists in soul-life, — when one analyzes the psychic processes no residue remains. The soul-atom as substance is a survival of metaphysics.

The atom is the absolute constant of the material world, and as to quantity and quality unchangeable. All change is traced back to the arrangement and motion of the atom. If one carries this idea over to psychic life then one destroys the concept or the life. The soul is not unchangeable and constant like the atom, but constant transformation is its characteristic and as the atom may, the soul never returns to a former condition. So you cannot speak of the soul as substance in the sense of being atomic.—Paulsen.

"Man's soul [4] is a description of reality *sub specie aeterim;* it is an image of God. God enters, as it were, in parts with every sense-impression into sentient creatures, and his likeness grows in clearness as the traces thus produced in living feelings reconstruct the World-Logos, which in man's soul appears as the divine spark called Reason." — Carus.

We have now given a very incomplete résumé of ideas of the soul that may be classified as philosophical, they should be regarded, in some measure, as representative rather than a complete list. Certain lines of thought have been influential as determining the attitude philosophers have taken, as, for example, the standpoint of empiricism followed generally by English writers, and until recent years the domination of idealism in Germany. The point of departure is, to a large extent, the factor determining the significance a philosopher will at-

[1] Sensual Philosophy of the 19th Century, p. 142.
[2] Metaphysics, pp. 339 and 344.
[3] Einleitung in die Philosophie.
[4] The Surd of Metaphysics, p. 60.

tach as to the meaning of mind or soul. He has before him the problem to explain certain sets of facts, and to establish harmony among them. The most important of these facts are as follows: given the belief in an immortal part of the body, mind or soul, and the belief in a supreme being to establish a relationship that will be consistent with the universe as a whole. The kind of explanation depends upon the facts supposed to be known of each. Thus the philosophical conception of the soul presupposes a larger view of things than that of either theology or psychology alone.

The influence of the beginnings of science can be noted in the explanations given of mind at that time and the reactions to the church in such conceptions as are presented by Voltaire. Taking its impetus from Leibnitz the dynamic view of life, *i. e.*, as a development of some form, found favor with philosophers before Darwin presented his biological evidences in favor of it; the soul finding its perfection in God. Its spiritual nature is thus recognized by Lessing, Schelling, Hegel, and other idealists, similar in essence to the Absolute Being. For Schopenhauer it takes the form of will. Later writers have not contributed much. The philosophical conception, as based on the development of animal life has, perhaps, not yet been fully worked out.

From the developed sciences there will always be a search for laws and general principles; thus as new sciences are evolved there will continually be new elements of knowledge contributed toward what is considered the Absolute. These new elements will likewise be contributions to our knowledge of soul. The term soul is one too large for any one science, each contributes its part toward our knowledge of it.

[Continuation follows in the next number.]

"GENERAL INTELLIGENCE," OBJECTIVELY DETERMINED AND MEASURED.

By C. SPEARMAN.

TABLE OF CONTENTS.

		PAGE
Chap. I.	Introductory.	
	1. Signs of Weakness in Experimental Psychology	202
	2. The Cause of this Weakness	203
	3. The Identities of Science	204
	4. Scope of the Present Experiments	205
Chap. II.	Historical and Critical	
	1. History of Previous Researches	206
	2. Conclusions to be drawn from these Previous Researches	219
	3. Criticism of Prevalent Working Methods	222
Chap. III.	Preliminary Investigation	
	1. Obviation of the Four Faults Quoted	225
	2. Definition of the Correspondence Sought	226
	3. Irrelevancies from Practice	227
	(a) Pitch	228
	(b) Sight	232
	(c) Weight	233
	(d) Intelligence	233
	4. Irrelevancies from Age	233
	5. Irrelevancies from Sex	235
	6. The Elimination of these Irrelevancies	236
	7. Alternations and Equivocalities	238
Chap. IV.	Description of the Present Experiments	
	1. Choice of Laboratory Psychics	241
	2. Instruments	242
	(a) Sound	243
	(b) Light	244
	(c) Weight	245
	3. Modes of Procedure	246
	(a) Experimental Series I	246
	(b) " " II	247
	(c) " " III	248
	(d) " " IV	249
	(e) " " V	249
	4. The Estimation of Intelligence	249
	5. Procedure in Deducing Results	252
	(a) Method of Correlation	252
	(b) Elimination of Observational Errors	253
	(c) Elimination of Irrelevant Factors	255
Chap. V.	The Present Results	
	1. Method and Meaning of Demonstration	256
	2. Correspondence between the Discrimination and the Intelligence	259

		Page
	(a) Experimental Series I	259
	(b) " " II	263
	(c) " " III	264
	(d) " " IV	265
	(e) Conclusions	268
	3. Correspondence between General Discrimination and General Intelligence	268
	(a) Village School	269
	(b) The High Class School	269
	(c) Practical Verification of the Argument	271
	(d) Conclusion	272
	4. Universal Unity of the Intellective Function	272
	5. The Hierarchy of the Intelligences	274
	6. Outer Factors Determining the Amount of Correlation	277
	7. Previous Researches Conflicting with the Present Results	279
	8. Summary of Conclusions	283
Appendix.	Tabular Statements of Original Data and Calculated Correlations	286

CHAPTER I.

Introductory.

1. *Signs of Weakness in Experimental Psychology.*

To-day, it is difficult to realize that only as recently as 1879 Wundt first obtained from the authorities of Leipsic University one little room for the then novel purpose of a "psychological laboratory."

In twenty-four years, not only has this modest beginning expanded into a suite of apartments admirably equipped with elaborate apparatus and thronged with students from the most distant quarters of the globe, but all over Germany and in almost every other civilized country have sprung up a host of similar institutions, each endeavoring to outbid the rest in perfection. The brief space of time has sufficed for Experimental Psychology to become a firmly established science, everywhere drawing to itself the most vigorous energies and keenest intellects.

But in spite of such a brilliant career, strangely enough this new branch of investigation still meets with resolute, wide spread, and even increasing opposition. Nor are its enemies at all confined to belated conservatives or crotchety reactionaries; they are rather to be found among the most youthful schools of thought; their strength may be in some measure estimated from the very elaborate apology which one of the best known experimental psychologists has lately found himself called upon to utter on behalf of his profession.[1]

[1] Münsterberg: "Die Grundzüge der Psychologie."

And, indeed, when we without bias consider the whole actual fruit so far gathered from this science—which at the outset seemed to promise an almost unlimited harvest—we can scarcely avoid a feeling of great disappointment. Take for an example Education. This is the line of practical inquiry that more than all others has absorbed the energy and talent of the younger workers and that appears to offer a peculiarly favorable field for such methods. Yet at this moment, notwithstanding all the laborious experiments and profuse literature on the subject, few competent and unprejudiced judges will venture to assert that much unequivocal information of capital importance has hitherto thus come to light. Nor have the results been more tangible in Psychiatry or in any other department of applied psychology.

Those, then, who have the highest opinion concerning the potentialities of this new science, will feel most bound to critically examine it for any points of structural incompleteness.

2. *The Cause of this Weakness.*

Most of those hostile to Experimental Psychology are in the habit of reproaching its methods with insignificance, and even with triviality. They regard it as an infatuation to pass life in measuring the exact average time required to press a button or in ascertaining the precise distance apart where two simultaneous pinpricks cannot any more be distinguished from one another; they protest that such means can never shed any real light upon the human soul, unlock the eternal antinomy of Free Will, or reveal the inward nature of Time and Space.

Such blame, however, would appear ill founded—at any rate, in principle. This same apparent triviality lies at the base of every successful science. The three laws of Newton on first inspection are by no means remarkably significant; yet by a large number of instructed persons they have been found implicitly to contain the supreme key to every event on the earth below and in the heavens above. When starting any new branch of mathematics, again, most people have had occasion to be astonished at the curious suddenness with which the seemingly shallow beginnings have shelved down into drowning deep water. The general fact is that our limited intellects can only hope to deal with the infinite complexity of Nature after analyzing it down into its bare unæsthetic elements.

On the other hand, it must frankly be admitted that such a procedure is, after all, only indirect; that it does not immediately handle the things which really interest us, but other things which are believed to accurately enough betoken the former; that the results arrived at concerning the simpler terms are therefore always worthless, except in proportion as their

elements have been proved beyond dispute to be identical with those of the more complex terms. Now, even in physical sciences this proof is not such an infallible operation that we can afford to neglect the possibility of lurking errors which may vitiate all our conclusions; and in psychical research such dangers are enormously magnified. When we pass an electric current through water until it vaporizes away into bubbles of hydrogen and oxygen, we can with reasonable precautions be tolerably certain that we have still got in our jars almost the whole of the same material substance, only reduced to simpler forms. But when we assert that the decision of Regulus to vote against making peace with Carthage was no more than a conglomeration of visual, auditory, and tactual sensations in various stages of intensity and association, then there is an undeniable risk that some precious psychical elements may have slipped through our fingers.

On this vital matter, it must reluctantly be confessed that most of Wundt's disciples have failed to carry forward the work in at all the positive spirit of their master. For while the simpler psychoses of the Laboratory have been investigated with great zeal and success, their identification with the more complex psychoses of Life has still continued to be almost exclusively ascertained by the older method of introspection. This pouring of new wine into old bottles has not been to the benefit of either, but rather has created a yawning gulf between the Science and the Reality. The results of all good experimental work will live, but as yet most of them are like hieroglyphics awaiting their deciphering Rosetta stone.

3. The "Identities" of Science.

Here, we naturally arrive at the important question as to what actually constitutes "identity" for scientific purposes.

As regards the material atoms of the physical sciences, this relation is of two orders. There is the Identity in the looser use of the word, which really means no more than uniformity of potential function, or the fact of having like reactions under like conditions; this alone constitutes the proper topic of the science. And then there is the true Identity involved in the metaphysical idea of persistence of substance, which in science is only a convenient working hypothesis to aid in establishing uniformities of the former order.

For psychology, also, the identification is of two orders. First, there is once more Uniformity of Function, and again this appears to be the proper topic of the positive science. But the second order is quite disparate from anything in physics, being that of inward resemblance as ascertained by introspection; such a "Conceptual Uniformity," though in metaphysics per-

haps of primary importance, in psychology is but an indispensable substructure—and one of lamentable fallibility. It cannot even be forthwith assumed necessarily to imply complete Functional Uniformity; and it is peculiarly insusceptible of scientific precision, propositions scarcely ever admitting of either decisive confirmation or refutation.

Now, it is one of the great merits of experimental psychology to have largely introduced the direct investigation of these Functional Uniformities, which have the infinite advantage of being eventually susceptible of conclusive proof, and on being securely established are in their turn capable of throwing back a valuable corrective light upon the Conceptual ones also. So far, however, this matter of research seems to have been almost entirely confined to such correspondences as are approximately complete (these, indeed, being the only ones attainable without a new development of methodics). But the vast majority of the functional relations are not thus complete; they are more or less thwarted by other factors; they outwardly present themselves only in the form of stronger or weaker *tendencies*. And precisely of this incomplete nature are most of the Functional Uniformities which connect the psychics of the Laboratory with those of real Life.

4. Scope of the Present Experiments.

The present article, therefore, advocates a "Correlational Psychology," for the purpose of positively determining all psychical tendencies, and in particular those which connect together the so-called "mental tests" with psychical activities of greater generality and interest. These will usually belong to that important class of tendencies produced by community of organism, whereby sufficiently similar acts are almost always performed by any one person in much the same manner; if, for example, he once proves good at discriminating two musical tones, he may be expected to manifest this talent on any subsequent occasion, and even in another portion of the scale.

For finding out the classes and limits of these individual functions, modern psychology seems to have mainly contented itself with borrowing statements from the discredited "faculties" of the older school, and then correcting and expanding such data by inward illumination. The following work is an attempt at the more fatiguing procedure of eliciting verifiable facts; the good intention and the difficulty of such an enterprise may, perhaps, be allowed to palliate the shortcomings in its execution. Our particular topic will be that cardinal function which we can provisionally term "General Intelligence;" first, there will be an inquiry into its exact relation to the Sensory Discrimination of which we hear so much in

laboratory work; and then—by the aid of information thus coming to light—it is hoped to determine this Intelligence in a definite objective manner, and to discover means of precisely measuring it. Should this ambitious programme be achieved even in small degree, Experimental Psychology would thereby appear to be supplied with the missing link in its theoretical justification, and at the same time to have produced a practical fruit of almost illimitable promise.

CHAPTER II.

HISTORICAL AND CRITICAL.

1. *History of Previous Researches.*

Though, as above stated, mental correlation has in general met with great neglect, yet a certain number of psychologists, including several of the best known, have from time to time turned their attention that way also. It therefore seems advisable, before entering into the present work, first briefly to survey the results of these previous researches; they will be found on the whole to indicate some very remarkable conclusions.

Only those correspondences will be taken into account in which both terms compared are of a psychical nature; many investigators, after determining the chief measurements of their subject's mind, proceed to make their record still more complete by also noting his most prominent bodily characteristics and external relations, such as his height and weight, the shape of his head, the color of his eyes and hair, the birthplace of his mother, etc. Such considerations, however interesting, do not quite fall within the scope of the present inquiry.

Galton. The first hint appears to have come from that suggestive writer, Francis Galton. As early as 1883, the latter stated that he had found men of marked ability to possess on the whole an unusually fine discrimination of minute differences in weight.[1] The pregnancy of this idea is unmistakable. But Galton appears to have been diverted from the point by other interests, and to have contented himself with the above general impression, without clinching the matter in systematic investigation. In 1890, however, on Cattell publishing an article about "Mental Tests and Measurements,"[2] a remark was appended by Galton suggesting the desirability of comparing such laboratory values with "an independent estimate of the man's powers. . . . The sort I would suggest is some-

[1] "Inquiries into the Human Faculty." [2] Mind, 1890, p. 380.

thing of this kind,—'mobile, eager, energetic; well shaped; successful at games requiring good eye and hand; sensitive; good at music and drawing.'" It will be seen that subsequent investigators have unanimously preferred a much less lively programme.

Oehrn. The earliest actual experiments in mental correlation seem to have been those of Oehrn,[1] in 1889, which at the same time furnished the starting point for that special branch termed by him, and now popular as, "Individual Psychology." The latter must, however, be fundamentally distinguished from the "Correlational Psychology" here advocated. For the former deliberately bases itself upon introspectively determined faculties and upon mental tests; whereas the latter *begins* by empirically ascertaining both the faculties and the precise value of the tests. The former endeavors to discover those small deviations from general law which constitute "individuality;"[2] while the latter, on the contrary, proposes methodically to eliminate individualities as an obstacle to further progress, being itself, no less than General Psychology, in search of laws and uniformities.

Oehrn tested ten subjects in Perception ("Wahrnehmungsvorgang"),[3] Memory, Association, and Motor Functions. In accordance with his standpoint of a priori assumed faculties, he does not correlate the results with any independent estimate of his subjects' intellectual powers, but only the tests with one another. He eventually comes to the conclusion that Perception, Memory, and the Motor Functions are "proportional to one another," but that Association is rather inverse to all the others!

Boas. The comparison desired by Galton between these laboratory tests and on the other hand the psychics of practical life was, as far as I am aware, first undertaken seriously by Boas. In 1891, the latter examined no less than 1,500 school children as to their Sight, Hearing, and Memory; and then—following the example of the semi-anthropometrical correlations of Porter and others—he proceeded to compare their performances in the above respects with their "Intellectual Acuteness" (as estimated by their teachers). On the first two heads, un-

---

[1] "Experimentelle Studien zur Individual-Psychologie," Dorpater Dissertation, 1889.

[2] Oehrn and Krapelin propose to study "the fine deviations from the great fundamental features of psychical conformity to law;" or again, "to determine the essential differences between minds."

[3] Even the term "individual" does not seem very happy, since it chiefly awakens the impression of dealing with individuals as contrasted with masses. In this latter and much more appropriate sense, Wundt uses "Individual Psychology" in opposition to his "Folk Psychology" (Grundriss der Psychologie, p. 28).

fortunately, the results have never been published. But as regards Memory, wherein his method of procedure in the main resembled that of Oehrn, the facts elicited were elaborated by Bolton,[1] who comes to the following conclusions:

"The Memory Span increases with Age rather than with the growth of Intelligence."

"The Memory Span measures the power of concentrated and prolonged Attention."

"Intellectual Acuteness, while more often connected with concentrated Attention, does not require it, and it cannot be said that those pupils who are bright intellectually are more distinguished on account of their good memories."[2]

It will be observed that these results are in sharp antagonism with the view of many modern psychologists, notably Wundt, who would make Attention the very essence of intellectual power.

Gilbert. In 1893, at New Haven, another series of experiments was carried out upon an almost equally extensive scale, and is still among the most important contributions to the subject. J. Gilbert applied several mental tests to about 1,200 children of both sexes, and then compared the results with their "general ability" (again as estimated by their respective schoolmasters).[3]

On this occasion, the original assertion of Galton was to some extent practically corroborated. For Gilbert believes himself to find a real correspondence of Intelligence with Sensory Discrimination both of weights and of shades. He also, like Bolton, discovers a slight correspondence with Memory; in Gilbert's experiments the child, instead of learning by heart a row of figures, had to give his judgment as to when a musical tone had lasted just as long as a previously sounded standard one.

But the correspondence deemed most positive and conspicuous was that between Intelligence and "Reaction-time." This is particularly suggestive, on reflecting how especially this Reaction-time depends upon concentration of the Attention. The indication would therefore accord rather with Wundt's view than with that of Boas. Curiously enough, when the Reaction-time is made more obviously intellectual by further complications (Discrimination and Choice), then the above correspondence becomes reduced in amount.

Scripture. In the same little volume, appears an account of an interesting experiment by Scripture, as to the correspondence

[1] *Am. Jour. of Psych.*, Vol. IV, p. 362.
[2] *Am. Jour. of Psych.*, Vol. IV, pp. 379, 365, and 366.
[3] Stud. Yale Psych. Lab., Vol. II, p. 40.

between shortness of Reaction-time and swiftness in lunging with foils. Unfortunately, his subjects are only seven in number. He feels himself, however, "fully justified" in coming to the conclusion that "the average fencer is not quicker in simple reaction than a trained scientist, and neither class shows an excessive rapidity."[1]

The first part of the above sentence would well harmonize with the intellectuality found also by Gilbert to be connected with speed in pressing a button; but the latter part is difficult to reconcile therewith, at any rate without painfully lowering the credit of "trained scientists."

Dresslar. Also in 1893, a quite new kind of correlational factor is investigated, that of natural illusions. As is well known, if we pick up two things of the same weight but of different size, we are almost irresistibly inclined to estimate the larger one as being the lighter of the two; strangely enough, the illusion still persists even after we know that the weights are really equal. Some 173 boys and girls were tested in this respect by Dresslar, and at the same time were classed by their teachers into "bright," "good," and "dull."[2] Dresslar found that the phenomenon was perfectly constant throughout the ages tested, 7 to 14 years, and that instead of the fallacy chiefly affecting the stupid children, as might have been expected, it on the contrary showed itself the more powerful in proportion as the child was "brighter;" hence he concluded: "The more intelligent the children, other things being equal, the stronger are the associations between the ideas of size and weight."

Griffing. In the following year, H. Griffing examined the other chief aspects of Attention.[3] The two former workers had dealt with its concentration or *in*tensity; Griffing now inquires about its amplitude or *ex*tensity. He does this by the well-known method of "tachistoscopy:" a number of syllables are exposed to view for a very brief moment, and the subject has to try how many he can read in this practically simultaneous manner.

The result of two independent sets of such experiments is in both cases that "the brighter students tend to excel."

Bourdon. About now we come upon a new and significant phenomenon in the course of these researches. The latter, though originally prompted in England, had forthwith been transplanted to America, in which country alone up to the present date they had been cultivated so as to bear fruit. But at

[1] Stud. Yale Psych. Lab., Vol. II, p. 122.
[2] *Amer. Jour. Psych.*, Vol. VI, p. 343.
[3] *Amer. Jour. Psych.*, Vol. VII, p. 227.

length the Old World also woke to the necessity of answering the questions. France led the van, soon bestowing upon the problem an original and characteristic impress.

In August, 1895, appeared an article by Bourdon entitled "Recognition, Discrimination, and Association."[1] For this investigation, about a dozen subjects were tested in

(1) the power of recognizing words previously shown to them;

(2) the power of quickly and accurately erasing from a printed page certain given letters of the alphabet (this was one of Oehrn's tests for "den Wahrnehmungsvorgang");

(3) the number of ideas arising in the mind within one minute on a given suggestion.

The conclusion arrived at[2] is that all three faculties present some correspondence with one another, but that this is much most marked between Recognition and Association.

Thus upon this occasion, as in the work of Oehrn, the mental tests were only compared with one another, and not with any independently obtained estimate of Ability. Like the German, Bourdon appears to consider that these three faculties, Recognition, Discrimination, and Association, are so satisfactorily represented by the tests,[3] that any otherwise gained values of Intelligence would merely be vaguer and less trustworthy versions of the same data.[4]

Binet and Henri. Again in France, towards the end of the year, there appeared an important article of similar tendency, bearing the well-known signatures of Binet and Henri[5] and setting forth the urgent need of "studying the relations that exist between different psychical processes." They propose the following ten tests: Memory, Mental Images, Imagination, Attention, Faculty of Comprehending, Suggestibility, Æsthetic Sentiment, Moral Sentiments, Muscular Force and Force of Will, Cleverness and "Coup d'oeil." By these means, they hope to measure off "a personality" in a fairly exhaustive manner within 1 to 1½ hours.

In the tests themselves, there is a new feature to be noticed. Hitherto, these had been of the most elementary and unequivocal nature possible, as befits the rigor of scientific work. But

[1] Revue philosophique, Vol. XL, p. 153.

[2] Based only upon nine of the subjects, for some had not undergone all three tests.

[3] Same article, p. 185.

[4] "La méthode à laquelle j'ai eu recours pour étudier ce phénomène (de la Reconnaissance) . . . pourrait servir a déterminer assez promptement et avec une rigeur satisfaisante quelle est l'aptitude d'une personne à reconnaître." And similarly for the other two faculties.

[5] L'année psychologique, Vol. II, p. 411.

this very simplicity had much increased the difficulty of making the test truly representative of any more complex psychosis. Binet and Henri appear now to seek tests of a more intermediate character, sacrificing much of the elementariness, but gaining greatly in approximation to the events of ordinary life. The result would seem likely to have more practical than theoretical value.

Next year Binet begins to put his interesting programme into execution.[1] He examines about 80 children and 6 adults as to powers of describing a picture shown to them, and by this means discovers the existence of five fundamental types of character, the "describer," "the observer," "the erudite," "the emotional," and "the idealist." "It is perhaps the first result," Binet remarks, "that has hitherto been produced by the experimental study of the higher intellectual faculties."

Binet then compares these new types with "the notes and comments which the professors wrote about their pupils and which the Director of the school has carefully checked." But as to the result of this comparison, unfortunately, only the following brief remark is made public: "Of five pupils whom I had put into the 'emotional' group, four had a cold temperament, a dry nature, and a little sensitiveness; the fourth alone seemed sensitive."

Sharp and Titchener. The above work of Binet and Henri found a speedy re-echo from the other side of the Atlantic. Some experiments with the avowed object of examining this new class of test are now recorded as taking place at Cornell University under the direction of Dr. Sharp and with the aid of Prof. Titchener.[2] These were expressly intended to depart from the older "German procedure" of dealing solely with the "elementary mental processes," and instead were to subject to trial the "French procedure" of directly handling the "complex" ones.

The following classification was adopted: Memory, Mental Images, Imagination, Attention, Observation, Discrimination, and Taste. The subjects consisted of three male and four female advanced students. No independent information was obtained concerning the subjects' respective mental powers, it being only attempted to ascertain whether the tests were consistent among themselves.

The results are not very encouraging:

"The lack of correspondences in the individual differences observed in the various tests was quite as noticeable as their presence."

---

[1] L'année psychologique, Vol. III, p. 296.
[2] *American Jour. Psych.*, Vol. X, p. 348.

"But little result for morphological psychology can be obtained from studies of the nature of the above investigation."

"In the present investigation the positive results have been wholly incommensurate with the labor required for the devising of tests and evaluation of results."

In conclusion, Sharp suggests the advisability of judiciously combining the characteristics of both the French and German procedures with one another.

Wagner. Almost simultaneously, the idea of collating mental tests with more practical methods of appraisement begins to take root in Germany also. In 1896, a series of experiments for the purpose of inquiring into the question of fatigue of school children was carried out at Darmstadt under the direction of Dr. Wagner.[1] The children were from the new Gymnasium there and seem to have amounted in all to 44 (though the information on this point is not very definite.) The test investigated was the old one of Weber which had recently again been brought to the notice of pedagogical circles by Griesbach. As is well known, it consists in ascertaining how near together two points can still be distinguished from one another by touch. On this occasion, care was taken to obtain an estimate of every child's Natural Talent (Begabung), Industry, Attentiveness, Nervousness, and sometimes Temperament.

Unfortunately for our present purpose, the intention of the experiment was not so much to correlate these psychical qualities with the children's absolute sensitivity, as with the reduction in such sensitivity produced by the fatigue of lessons. This reduction is stated to correspond closely with the amount of Attention paid by the child, but to be almost independent of his Natural Talent. Once more, therefore, Attention and Ability are contrasted instead of being identified.

As far as concerns the children's unfatigued condition, our real present topic, we only learn that the nervous and indisposed have a less fine tactual sensitivity than the others.

Ebbinghaus. About the same time, another and much more extensive investigation was officially instituted in Silesia for the same purpose. Two entire upper schools, a boys' Gymnasium and a girls' High School, were before and after work subjected to three tests: the two old ones of Oehrn for Memory and Association (memorizing and adding numbers respectively), and the new "Combination Method"[2] of Ebbinghaus. The latter observer in discussing the results devotes no less than one entire section out of four to considering the rela-

---

[1] Sammlung von Abhandlungen a. d. Gebiete der päd. Psych., Vol. I.

[2] In this, a purposely defective text is given to the subject, and the latter has conjecturally to fill in the missing parts.

tions shown between these tests and the children's general intellect.[1]

He comes to the conclusion that the school order shows an appreciable correspondence with all three tests, but least so with Memory and most with his own new Combination Method. He particularly points out that in the last mentioned this correspondence applies, not only to difference of class, but also to position within each class; whereas in the case of Memory, he thinks that if anything the least intelligent succeed the best!

The Combination Method would appear to resemble the new type of test recommended by Binet and Henri, to the extent of presenting a rather intermediate character between the elementariness of normal laboratory work and the complexity of practical activities.

Wiersma. To depart for a moment from the chronological to the logical order of events, this favorable verdict of Ebbinghaus concerning his own new method was in 1902 strongly corroborated by some experiments of Wiersma.[2] This time, three schools were brought into service. Two of them were special training establishments for male and female teachers respectively, from fourteen to nineteen years old. The third was a "Nachbildungs" School, namely, one for those of both sexes who had already gone through the six classes of the elementary school; they consequently aged from eleven to fourteen. The total number came to about three hundred.

Following closely in the steps of Ebbinghaus himself, Wiersma finds his average results to improve regularly with the higher classes and with the higher sections of each class. He takes great pains to analyze the factors upon which such school position depends, and arrives at distinguishing Age, Educational Development (Entwickelung), and Natural Talent (Begabung). In many complicated tables and graphs, he marshals evidence that the observed correspondence is most of all due to the last named factor.

Binet and Vaschide. In 1897, the question is again attacked by Binet, now in partnership with Vaschide.[3] But there is a remarkable return, as far as psychics are concerned, to the old less aspiring forms of tests. For he once more examines children in Reaction-time, Reaction-time with Choice, and Memory of Numbers. In addition thereto, he devises the ingenious test of motor ability called Dots ("petits points"); this consists in seeing how often the subject can tap with a pen on a piece of paper in 5 seconds. The intellectual order of the

---

[1] Zeitschrift für Psychologie und Physiologie, Vol. XIII, p. 401.
[2] Zeitschrift für Psychologie und Physiologie, Vol. XXX, p. 196.
[3] L'année psychologique, Vol. IV.

children was again obtained from their respective ranks in class. The subjects numbered 45 and averaged about 12 years of age. The results are exactly opposite to those of Gilbert, for Binet sums up as follows:

"The Intellectual Order harmonizes badly with Reaction-times and harmonizes well with the Memory of Numbers." But better than either appears the correspondence with his own "Dots."

This work was quickly followed by similar tests upon older subjects. For such purpose, Binet and Vaschide turned to the Normal School of Teachers at Versailles and there examined 43 youths ranging from 16 to 20 years of age.[1] This time, the scanty positive results of the former experiments are still further reduced; for even the correlation with Memory is somewhat less in evidence. The relation with the "Dots" again presents an unbroken regularity, but this time it seems to have become *inverse*, the stupidest tapping with the greatest speed!

Seashore. We next come upon an interesting series of carefully conducted experiments, to which we shall frequently have occasion to refer. It took place from 1897 to 1899 at the University of Iowa, under the direction of Dr. Seashore, the subjects being nearly 200 children varying from 6 to 15 years inclusive.[2]

Here, the negatory note that we have first heard from Binet is reiterated, and now in much fuller tones. As regards General Intelligence (again as estimated by the teachers) and Memory of Time, between which Gilbert had found a very marked correspondence, Seashore on the contrary disposes of the question in the following brief words: "There appears to be no functional relation between the two processes."

So, too, between Intelligence and Discrimination of Pitch. For while Gilbert believed himself to have discovered some such correlation, Seashore again says curtly: "There is no functional relation; the distribution of the results practically coincides with the most probable distribution according to chance."

He further compares General Intelligence with the faculty of discriminating Loudness and with various Illusions of Form, Color and Weight. In each case, he finds himself forced to the same conclusion, that there is no indication of the bright children doing differently from the dull ones.

Pearce. Again temporarily deserting the chronological order, some other illusional experiments were carried out in 1903 by H. Pearce.[3] These dealt with the subjective localization of

---

[1] L'année psychologique, Vol. IV. [2] Stud. Psych. Iowa, Vol. II.
[3] Archiv für die gesammte Psychologie, Vol. I, Part 1.

touch sensations and indicated that judgment tends to be warped by other immediately preceding touch sensations in the same neighborhood of the skin. Pearce tested 32 children in this way and came to the conclusion that the warp is directly proportional to the child's intelligence. While thus corroborating Dresslar rather than Seashore, he differs even from the former in that he declares the fallacy to diminish continually with increase of age.

Bagley. The negations of Binet and Seashore were soon carried to a still further extreme. W. Bagley, experimenting at Madison upon 160 children,[1] corroborates Binet to the effect that Reaction-time shows no correspondence with School Intelligence, and also supports the latter's second and inverse rather than first and direct result with "Dots;" for Bagley not only denies all correspondence between any motor abilities and mental ones, but believes his work to demonstrate positively that there is even a marked antagonism between the two, so that excellence in either direction is apt to be accompanied by deficiency in the other.[2]

Carman. In 1899, at Saginaw, there was another investigation which, if we are to go by the number of children tested, must be judged the most important that has taken place up to this day.[3] A. Carman examined 1,507 of them as to their sensibility to pain (and also their strength of hand), noting in each case, as had now become usual, whether the teacher pronounced them to be "bright," "average," or "dull." Not much detail is given, but the following general conclusions are arrived at:

"Boys reported by their teachers as bright were more sensitive than those reported as dull."

"Girls reported as bright were more sensitive and stronger than those reported as dull."

"Those reported as being especially dull in mathematics were more sensitive on the right temple than on the left."

It is further discovered that

"Girls with light hair and blue or gray eyes are less sensitive to pain on left temple," but "on right temple they are more sensitive than the dark."

This information is very curious.

Kirkpatrick. In 1900, a slight rally against the emphatic denials of Binet, Seashore, and Bagley is attempted by E. Kirkpatrick.[4] About 500 children were tested in three "sim-

---

[1] *Am. Jour. of Psych.*, Vol. XII, p. 193.

[2] The relation between motor and mental ability appears to have also been treated by Handcock, Peckham, and Porter, but I have not been able to obtain access to their works.

[3] *Am. Jour. of Psych.*, Vol. X, p. 392.

[4] Psych. Review, Vol. VII, p. 274.

ple motor activities," including Binet's Dots, Counting Aloud, and Sorting Cards; their respective performances were then compared with their degrees of intelligence as estimated in the usual way by their teachers.

The result is in every case a decided correspondence.

Thorndike and Woodworth. Hitherto, we have only seen attempts to ascertain what I may, perhaps, be allowed to call "statical correlation." But in 1901, Messrs. Thorndike and Woodworth make a vigorous onslaught upon the still more important and difficult "dynamical correlation." It is useful enough to know whether any child that "taps," etc. with unusual slowness may thereupon straightway be considered as "dull;" but it would be even more to the point to learn that daily practice with the tapping machine could make him any brighter.

Various previous researches had been distinctly encouraging in this matter. Stumpf declares: "The power of mental concentration upon certain points, in whatever region acquired, will show itself effectual in all others also."[1] Gilbert and Fracker had found that practice in one form of discrimination or reaction-time brought with it improvement in the other forms.[2] Scripture writes, intending apparently to include intellective activities: "Development of will power in connection with any activity is accompanied by a development of will power as a whole."[3] And again, Davis comes to the conclusion that "practice in any special act" develops ability "for all other acts."[4]

Formal discipline

The experiments of Thorndike and Woodworth, however, give once more a flat negation. The indications are rather that the effect of training in any one mental achievement is of little or no use for other intellectual performances, even very closely akin. The persons tested were carefully exercised until they had acquired considerable proficiency in judging the relative sizes of some pieces of paper of a particular shape. But this so obtained talent seemed completely to depart as soon as new tests were made with papers of a different shape, or even of a somewhat different size. Similar experiments in other sorts of feats led to the same result.

Binet. About the same time, we have another interesting and long contribution from Binet.[5] His subjects numbered eleven and were specially selected as being the five cleverest and the six most stupid out of a class of thirty-two. These

[1] Tonpsychologie, 1883, Part I, p. 83.
[2] Univ. Iowa Stud. Psych., Vol. I.
[3] Psych. Rev., Vol. VI, p. 165.
[4] Stud. Yale Psych. Lab., Vol. VI.
[5] L'année psych., Vol. VI, p. 248.

two groups, the "intelligent" and the "unintelligent," were in all the tests opposed and compared.

Binet again confirms, and more positively than ever, that Reaction-time, either with or without the complication of "Choice," has no correspondence with Intelligence. He also contradicts the correlation found by Griffing with the *ex*tensive dimension of Attention, in the form of simultaneously reading a large number of letters exposed to view for a small fraction of a second; though, curiously enough, Binet finds a certain amount of correspondence when he quite similarly exposes some arabesque designs. And finally, he finds no correlation with a new test of his own devising, namely: a trial how small a change in the rate of the beats of a metronome can be accurately detected.

But, on the other hand, his formerly successful method of Memory of Numbers now once more showed a marked correspondence with Intelligence. So also, and to a similar amount, is a correlation shown by Erasure of Letters (like that of Oehrn and Bourdon) and by Arithmetical Addition (more complicated than that of Ebbinghaus). So, again, do his new tests of Accuracy in Counting Metronome Taps and in Counting Dots. And so does his other new test, that of Copying: the subject is to copy a certain amount of writing, and then note is taken as to how many syllables he writes from each glance at the original; the more intelligent, the more words per glance.

But the fullest correspondence of all was presented by the very old test of Tactile Discrimination, which we have already seen successfully assayed by Wagner in 1896.

Binet is further strongly of opinion that all these correlations with Intelligence are most marked upon first trial, and that they continually diminish in proportion as the intelligent and unintelligent are both alike given more and more practice in the tests.

Simon. Directly inspired, apparently, by the last research, the correspondence there discovered between intelligence and the Copying test was now corroborated under new conditions. M. Simon conceived the idea that any such correlation should be manifested in especially prominent relief at the Vaucluse colony for backward children. He therefore tries seventeen of them, and finds in fact that, with one exception, all those classed medically as "Idiot" or "Imbécile" can copy fewer syllables at a time than do those merely termed "Dégénéré" or "Débile."[1] He concludes enthusiastically as follows:

"Convenient, short, and exact, this copying of phrases at once constitutes a good method of diagnosing a child's intellectual development at the very moment of the experiment."

---

[1] L'année psych., Vol. VII, p. 490.

Kraepelin, Cron. Other observers, however, would appear to have been less fortunate in this region. Their application of experimental tests, even to such trenchant opposition as intellectual health and disease, has not led them to results that they have felt able to pronounce entirely unequivocal. The careful work of Kraepelin and Cron[1] comes to the following close: "At the end of these considerations, we will not hide from ourselves that the obtained results have fallen far short of what one is accustomed to expect from collective experiments with the simplest 'mental tests.'"

Reis. When the above investigation was renewed on a more extensive scale by Reis, the latter finds indeed that these tests perfectly well admit of being executed upon the patients in the asylum; but the success would appear almost *too* great to fullfil the desired purpose, for often the patients prove the better performers of the two; a man, for instance, medically diagnosed as suffering from Dementia Paralytica with marked mental incapacity (deutliche geistige Schwäche) more than once comes out top of all fifteen subjects sane and insane alike.

Cattell, Farrand, Wissler. Now we come to about the latest and in many respects far the most important of all these attempts to correlate laboratory work with the psychics of real life. For amplitude of design, special experience of the directors, and lucid collation of the results, nothing up to the present has approached the researches which for about the last ten years have been progressing at Columbia University under the guidance of Cattell.

In 1896, the latter, together with Farrand, allowed a brief insight into the nature and extent of the proceeding being carried on. But not till 1901 was the total upshot of all this labor carefully put together and published by Wissler.[2] By that time, 250 freshmen and some 35 seniors of the University, besides about 40 young women in Barnard College, had undergone the following elaborate series of tests (in addition to others not belonging to the present topic, such as anthropometrical, etc.):

Perception of Size,	Reaction-time,
Strength of Hand,	Rate of Perception,
Fatigue,	Naming Colors,
Eyesight,	Rate of Movement,
Color-vision,	Rhythm and Perception of Time,
Hearing,	Association,
Perception of Pitch,	Imagery,
Perception of Weight,	Auditory Memory,
Sensation Areas,	Visual Memory,
Sensitiveness to Pain,	Logical Memory,
Color-preference,	and Retrospective Memory.

[1] Psych. Arbeiten, Vol. II, p. 324.
[2] Psych. Rev. Monograph Supplement, June, 1901.

The general intelligence of each student was settled by his average grading in all the different University courses; an amalgamation of these separate gradings resulted in forming eleven classes.

This class standing and all the above laboratory tests are now, for the first time in the history of the problem, correlated together with some mathematical precision. The final conclusions are about as blankly negative as could well be imagined. We are summarily informed that

"The laboratory mental tests show little inter-correlation."

"The markings of students in college classes correlate with themselves to a considerable degree, but not with the tests made in the laboratory."

And on inspecting the actual figures representing the faint correlations in question, it is mathematically evident that not one of them is more than would be expected to occur by mere accidental coincidence.

Aiken, Thorndike and Hubbell. Finally, in 1902, there appears an interesting contribution to the subject from Aiken, Thorndike, and Hubbell. Here "the functions in question were much more alike than were those examined by Wissler.[1] We have examined the relationships between functions in an extremely favorable case." Nevertheless, on the whole the previous negative results are once more strongly corroborated; when some mental functions usually regarded as most purely typical of the associative process are compared together, their correlation turns out to be "none or slight."

2. *Conclusions to be Drawn from these Previous Researches.*

Thus far, it must be confessed, the outlook is anything but cheerful for our project contemplated at the end of the first part, or, indeed, for Experimental Psychology in general. There is scarcely one positive conclusion concerning the correlation between mental tests and independent practical estimates that has not been with equal force flatly contradicted; and amid this discordance, there is a continually waxing inclination—especially noticeable among the most capable workers and exact results—absolutely to deny any such correlation at all.

Here, then, is a strange enough answer to our question. When Laboratory and Life, the Token and the Betokened, are at last objectively and positively compared as regards one of the most important Functional Uniformities, they would seem to present no correspondence whatever with one another. Either we must conclude that there is no such thing as general intelligence, but only a number of mental activities perfectly

[1] Psych. Rev., Vol. IX, p. 374.

independent of one another except for this common word to designate them, or else our scientific "tests" would appear to have been all so unhappily invented as to lie outside the widest limits of those very faculties of which they are supposed to form a concentrated essence.

It is true that Functional Uniformities might conceivably exist of other kinds; but for any such there is even less evidence; nor would they appear at all a priori probable, in view of the complete and surprising absence of that important one constituted by community of organism. Failing all Functional Uniformities, any connection between the experimental procedure and practical intelligence can then be no more than "Conceptual." But this is a position scarcely tenable for those whose chief claim is finally to have escaped from the endless tangle of purely introspective argument; moreover, such an admission would shear every experimental research of almost its whole worth and deprive the systems built thereon of their essential base.

Further, if thus the only correspondences hitherto positively tested, those between Intelligence and its variously supposed Quintessences, have totally failed to reveal any real existence, what shall we say of all the other by no means so apparently self-evident correspondences postulated throughout experimental psychology and forming its present backbone? To take one of the most extensive and painstaking of them, Dr. Schuyten, from 1893 to 1897, continuously amassed evidence to prove a close relation of the middle European temperature with the faculty of "voluntary attention" and even more generally with "the intensity of cerebral activity;" he seems to have repeated his observations on about five hundred different days, upon each occasion indefatigably proceeding round Antwerp from one school to another, visiting most of the time as many as eight. Now, his actual test of "voluntary attention" and "cerebral activity" consisted entirely in noting how many children kept their eyes on their lesson books for five consecutive minutes; but, as far as I am aware, there has not yet been any positive proof that this posture sufficiently coincides with all the other activities coming under this general term of "voluntary attention;" and in view of the universal breakdown of evidence for much more plausible correlations, Schuyten's a priori assumption can hardly be admitted as an adequate basis for his wide reaching theoretical and practical conclusions. To try another example, we have seen that a favorite test, successively adopted by Oehrn, Bourdon, and Binet,[1] is that of erasing from a printed page certain given letters of the alpha-

[1] The last named seems to have been the first to inquire into, rather than assume, the range of function involved in this test.

bet; but sceptics are still able to contend that because any person can dash a stroke through a's and i's with unusual speed, he need not therefore be summarily assumed to possess an abnormally large capacity for discrimination generally speaking, say, for telling a fresh from an over-night deer's trail, or distinguishing sound financial investments from unsound. Precisely similar criticism may be extended to almost the whole mass of laborious attempts to establish practical applications of Experimental Psychology, whether for pedagogical, medical, or other purposes.

Nor is the case much otherwise even with those stricter and more theoretical researchers who are rather inclined to regard as superficial any experiments involving large numbers of subjects. For however modest and precise may seem the conduct of their own actual investigation, it nearly always terminates with and justifies itself by a number of sweeping conclusions; and these latter will be found to essentially imply some assumed general function or process, such as "memory," "association," "attention," "fatigue," "practice," "will," etc., and at the same time that this function is adequately represented by the laboratory test. To take for instance the speed of mental association, there is hardly a psychologist of note who has not at some time or other made wide reaching assertions on this point, often indeed finding herein one of the pillar stones of his philosophy; the more practically minded, as Kraepelin and his school, content themselves with demonstrating the details of its actual conduct, showing us how the rate will rise with practice or on imbibing tea, how it sinks in proportion to fatigue or mental disorder, how under the influence of alcohol it for a brief moment slightly ascends and then becomes permanently and profoundly depressed. But all these conclusions are derived from observation of one or two supposed typical forms of this "association;" while the extensive experiments of Aiken, Thorndike, and Hubbell reveal that every form of association, however closely similar on introspection, must, nevertheless, always be considered separately on its own merits, and that "quickness of association as an ability determining the speed of all one's associations is a myth." [1] The most curious part of the general failure to find any correspondence between the psychics of the Laboratory and those of Life is that experimental psychologists on the whole do not seem in any way disturbed by it. But sooner than impute to them—the avowed champions of positive evidence—such a logical crime as to prefer their own a priori convictions to this mass of testifying facts, it is perhaps pardonable to suspect that many of them do not realize the full significance of the situation!

[1] Psych. Rev., Vol. IX, p. 375.

3. *Criticism of Prevalent Working Methods.*

There is, however, an intermediate way between ignoring all this serious testimony and submissively accepting it; this consists in subjecting it to the most searching criticism of which one is capable. But such a procedure quickly leads to questions of greater generality; if we would deal with the matter at all adequately, we are compelled to enter into a general discussion of the methods universally prevalent for demonstrating association between two events or attributes. To this important topic a special work has been devoted.[1] For the present, we must limit ourselves to the following brief exposition of the chief deficiencies appearing especially to characterize the long series of experiments just reviewed.

In the first place, only one out of them all (Wissler at Columbia) attains to the first fundamental requisite of correlation, namely, a *precise quantitative expression*. Many writers, indeed, have been at great trouble and have compiled elaborate numerical tables, even bewilderingly so; but nowhere do we find this mass of data focused to a single exact result. In consequence, not only has comparison always been impossible between one experiment and another, but the experimenters themselves have proved quite unable to correctly estimate even their own results; some have conceived their work to prove that correspondence was absent when it really existed to a very considerable amount; whereas others have held up as a large correlation what in reality is insignificantly small. Later on, we shall come upon examples of both kinds of bias. With this requisite is closely bound up another one no less fundamental, namely, that the ultimate result should not be presented in some form specially devised to demonstrate the compiler's theory, but rather should be a perfectly impartial representation of the *whole* of the relations elicited by the experiments.

Next, with the same exception as before, not one has calculated the "probable error;" hence, they have had no means whatever of judging how much of their results was merely due to *accidental coincidence*. This applies not only to the experiments executed with comparatively few subjects, but even to those upon the most extensive scales recorded. The danger of being misled by combinations due to pure chance does, indeed, depend greatly upon the number of cases observed, but in still larger degree upon the manner in which the data are calculated and presented.

Thirdly, in no case has there been any clear explicit definition of the problem to be resolved. A correspondence is ordi-

N. B. [1] "The Proof and Measurement of Association between two Things." *Am. Jour. Psych.*, XV., 72. N. B.

narily expressed in such a general way as neither admits of practical ascertainment nor even possesses any great theoretical significance; for a scientific investigation to be either possible or desirable, we must needs restrict it by a large number of qualifications. Having done so, any influence included (or excluded) in contravention of our definition must be considered as an *irrelevant and falsifying factor*. Now, in many of the experiments that we have been discussing, even in those upon quite a small scale, the authors have tried to kill as many birds as possible with one stone and have sought after the greatest—instead of the least—diversity; they have purposely thrown together subjects of all sorts and ages, and thus have gone out of their way to invite fallacious elements into their work. But in any case, even with the best of intentions, these irrelevant factors could not possibly be adequately obviated, until some method had been discovered for *exactly measuring* them and their effect upon the correlation; this, to the best of my knowledge, has never been done. As will presently be seen, the disturbance is frequently sufficient to so entirely transform the apparent correlation, that the latter becomes little or no evidence as to the quantity or even direction of the real correspondence.

Lastly, no investigator seems to have taken into any consideration another very large source of fallacy and one that is inevitably present in every work, namely, the *errors of observation*. For having executed our experiment and calculated the correlation, we must then remember that the latter does not represent the mathematical relation between the two sets of real objects compared, but only between the two sets of measurements which we have derived from the former by more or less fallible processes. The result actually obtained in any laboratory test must necessarily have in every case been perturbed by various contingencies which have nothing to do with the subject's real general capacity; a simple proof is the fact that the repetition of an experiment will always produce a value somewhat different from before. The same is no less true as regards more practical appraisements, for the lad confidently pronounced by his teacher to be "dull" may eventually turn out to have quite the average share of brains. These unavoidable discrepancies have always been ignored, apparently on some tacit assumption that they will act impartially, half of them tending to enhance the apparent correlation and half to reduce it; in this way, it is supposed, the result must in the long run become more and more nearly true. Such is, however, not at all the case; these errors of observation do not tend to wholly compensate one another, but only partially so; every time, they leave a certain balance *against the correlation*, which

is in no way affected by the number of cases assembled, but solely by the size of the mean error of observation. The amount of consequent falsification is in physical inquiry often unimportant, but in psychology it is usually large enough to completely vitiate the conclusion. This falsifying influence has in many of the above experiments, especially the more extensive ones, occurred in exaggerated form; for even those experimenters who are most careful in the ordinary routine of the laboratory have yet allowed themselves to be seduced by the special difficulties attending this sort of work; urged on the one hand by the craving after an imposing array of cases — somewhat ad captandum vulgus — and sternly restricted on the other side by various personal considerations (such as restiveness and fatiguability of the youthful subjects, fear of deranging school hours, etc.), they have too often fallen into almost incredibly hurried and inadequate methods of testing. Here, again, mere goodness of intention will not avail beyond a very limited extent, for the most painstaking work is far from entitling us to assume that the observational fallacy has been reduced to insignificant dimensions; we can have no satisfactory guarantee, until some method has been devised of precisely measuring the disturbance, and this does not seem to have ever been attempted.

The above criticism, of a perfectly general nature, must suffice for the bulk of the researches cited in this chapter; later on will be found a more detailed examination of those three particular ones which have dealt with precisely the same topic as the present article. If here methodological imperfections have admitted of formulation with unusual sharpness, the fact must by no means be taken as an especial condemnation of these and kindred experiments. Certain faults have, indeed, been especially prominent, as, for instance, the large errors of observation; but, on the whole, the majority of them would appear to contain at least as much good solid work as most of those more strictly confined to the laboratory and to a very small number of "trained" subjects; the former have only afforded a firmer foothold for criticism, because they have confined the question to a more simple unequivocal issue — though not yet nearly *enough* so — and because they have assailed their problem in a square positive manner. The final inconclusiveness of all their labor is not so much due to individual shortcomings of the investigators, or even of the whole branch of investigation, as to the general non-existence of any adequate system for proving and measuring associative tendencies.

Under all these circumstances, in spite of the many previous inconclusive and negatory verdicts, the question of correspondence between the Tests of the Laboratory and the Intelligence

of Life cannot yet be regarded as definitely closed. The only thing so far demonstrated is that the old means of investigation are entirely inadequate. The present undertaking, therefore, has only ventured once more to approach the problem, because believing to have elaborated a new and reasonably complete methodological procedure, such as appears capable of at last bringing light upon this and innumerable other important regions hitherto inexplorable.

CHAPTER III.

Preliminary Investigation.

1. *Obviation of the Four Faults Quoted.*

In the last chapter, four grave faults have been charged against the entire antecedent literature on the present topic. The first thing insisted upon was a *precise quantitative expression derived impartially from the entire available data;* we must renounce adroit manipulation of tables and graphs, still further rounded into the desired shape by ingenious argument; the whole of our experimentally gained figures must without any selective treatment simply of themselves issue into one plain numerical value (varying conveniently from 1 for perfect correspondence down to 0 for perfect absence of correspondence); this will here be done in the method that has been successively elaborated by Bravais,[1] Galton,[2] and Pearson,[3] and whose formula will be found on page 252; in addition, lists of individual amounts will be given in full as originally obtained, and therefore can be freely used either for checking the present results or for other inquiries. The second requisite was the probable error; concerning this it may at once be remarked that indispensable as is some evaluation, yet here less than anywhere else have we need, or even possibility, of rigorous exactness; approximate estimates will be appended to each correlation in tables. The third fault indicated was the one deriving from the errors of observation; little can be said in this place concerning the best means of reducing these to a minimum, for on such head our requirements are scarcely different from those already prevailing in all serious psychological research; only some matters of special interest will be briefly touched upon while describing the procedure of the present experiments in the next chapter. Much more important for us is the fact that

---

[1] Memoires par divers Savans, T. IX, Paris, 1846, pp. 255-332.
[2] Proceedings Royal Society of London, Vols. XL and XLV.
[3] Philosophical Transactions, R. S. London, Vol. CLXXXVII A, p. 164.

the total effect of all such errors can be measured *en masse* and mathematically eliminated, and that until this has been done, no correlational value can be assumed as even approximately accurate. The formulæ for this purpose are given and explained in the already mentioned article;[1] sufficient for the present practical purposes will be briefly recapitulated at the end of the next chapter.

The remaining point is that of irrelevant factors; this also is more fully explained in the said article; it involves a thorough preliminary investigation of all the terms concerned, without which the most skillful experimentation and lucid exposition will only be wasted labor; the produce of such preparatory exploration will form the remainder of the present chapter, while the processes of calculation will be given at the close of the next one.

2. *Definition of the Correspondence Sought.*

The first step towards eliminating irrelevancies is to clearly lay down how much we are to consider relevant, or in other words to properly define the problem at issue. As already stated, universal correspondences can never be the subject of investigation; in practice we are forced to introduce a large number of conventional restrictions, and for profitable work these must be explicit and unequivocal.

Let us first take that of *Kinship*. Putting other animals out of the question, we clearly cannot pretend adequately to sample even the whole existing human species. In order to obtain the simplest and least ambiguous results, it might seem desirable to reduce this source of variation to the least possible dimensions; an ideal experiment would then be wholly confined to a number of sets of brothers or sisters and to determining how far the more intelligent brother is also the better discriminator. But these narrow limits are most inconvenient on practical grounds, and even theoretically there appears no great objection against extending the kinship to any range that does not introduce inconvenient complications; we may eventually find it necessary to exclude differences of social stratum, of sex, etc.; or it may, on the contrary, be found allowable to admit all these and even some amount of internationality.

Next, we must bear in mind that the action of correctly distinguishing between two sounds or weights is a matter depending on many factors, and we must decide how many of these should be rejected as foreign to our purpose. In the present case, it seems best to limit the object of our research to that portion of the discriminating act which appears to constitute its

[1] "The Proof and Measurement of Association between Two Things."

specific core, excluding as far as possible such more outward influences as Zeal, Endurance, Manual Dexterity, Memory, etc. The last named requires especial attention, since it necessarily enters into all these mental tests. Its influence will greatly differ according to the method of procedure: the interval intervening between the two compared sensations may vary from a small fraction of a second to several minutes; it may leave the reagent's attention undisturbed, or it may make distracting calls upon it (such as causing him accurately to adjust an instrument). One of the investigations cited in the last chapter has gone so far in this direction, that a test called by the experimenters themselves "Perception of Pitch" is by the compiler preferably termed "Pitch *Memory*." [1] Now, the correlations of Memory — as far at any rate as my own researches have hitherto gone — would indicate laws entirely different from those of Discrimination; if this be confirmed, any interference of the former factor may gravely perturb an investigation into the latter.

Thirdly, the correspondence selected for inquiry in the present case is that between *natural innate faculties*. By this definition, we explicitly declare that all such individual circumstances as after birth materially modify the investigated function are irrelevant and must be adequately eliminated; our results might, therefore, be wholly vitiated if we threw together people in disparate ages, those in full vigor and those tired or ill, those who have already practised the test in question and those to whom it is new, etc. To obviate this, we are obliged to search through the records of previous work, so as to ascertain all the influences that have been found seriously to affect any of the variants now in question. The chief results of such a preparatory investigation will now be briefly detailed, and for the sake of conciseness and unequivocality we will at once as far as possible explain and correct these antecedent data by collating them with the information subsequently derived from the present experiments themselves. The most prominent turn out to be Practice, Age, and Sex, which will be discussed in this order.

3. *Irrelevancies from Practice.*

The importance of having defined our correlation will here at once be evident. For if we had wished to inquire whether

---

[1] Some experimenters (Lehmann, Angell), it is true, have found that "correctness of sensory judgment is practically independent of time interval" up to at least a minute, and even of deliberate distraction (Angell, Wundt's Phil. Stud., Vol. XVII, p. 11). I have, however, been unable to convince myself that this conclusion holds at all good for the ordinary conditions of experiment.

sensory acuteness and general intellect are correlated *dynamically*, if (as stated by many persons on the strength apparently of a priori reasoning) we had assumed that the discrimination of minute differences of sensation "is to be cultivated as the foundation of all intelligence,"[1] then we should have had to admit the variations due to Practice as perfectly relevant and we should have looked for a continual expansion in people's general ability in proportion to the labor they had expended on distinguishing tones, shades, and weights from one another. In the present experiments, however, it has been preferred to commence by investigating the *statical* relation; it has not been asked whether Intelligence is produced by development of sensory acuteness, but whether the former original endowment is on the whole accompanied by a corresponding amount of the latter also. From this it follows that we are bound to carefully eliminate differences of previous exercise.

(*a*) *Pitch*. In this branch of Discrimination the effects of Practice are especially conspicuous, but nevertheless they are not very easy to trace out with the quantitative precision required for our purpose. Experiment has, indeed, unanimously demonstrated that the threshold of discrimination to be reached by trained and competent acousticians, even when using quite different apparatus, is in the immediate neighborhood of 1/3 v. d.;[2] but there is no such general agreement concerning the average threshold of "unpractised" persons. Delezenne, for instance, finds that an interval equivalent in the centre octaves to about 1 v. d. "becomes sensible to the least practised ears, as I have assured myself on several people."[3] But Preyer, on the other hand (though quite agreeing with Delezenne as regards the powers of practised acousticians), tried a few unpractised persons and found that they could not all decide with certainty unless the two tones differed by as much as 8 v. d.[4] And

[3] Die Grenze der Tonwahrnehmung.

---

[1] Pulling: Teachers' Text book of Practical Psychology, p. 16.

[2] In the present work, it is taken that a threshold obtained in v. d. (= vibrations difference) for any tone within the two octaves above the middle C may be assumed also to hold approximately good for the remainder of these two octaves and both above and below gradually to augment. So much appears sufficiently demonstrated by the works of Preyer (Die Grenze der Tonwahrnehmung), Luft (Wundt's Phil. Stud., Vol. IV, pp. 511 ff.), and Meyer (Zeit. f. Psych. u. Phys., Vol. XVI, p. 352). Hence the results of all experiments conducted anywhere near the centre of the ordinary musical scale admit of being easily collated with one another. For procedure in comparing any values obtained by the method of "Minimal Changes" with those by "Right and Wrong Cases," see Lorenz (Wundt's Phil. Stud., Vol. II), Merkel (*Ibid.*, Vols. IV and VII), Kämpfe (*Ibid.*, Vol. VIII), and Mosch (*Ibid.*, Vol. XX).

[4] Recueil des travaux de la Soc. de Lille, 1827, p. 4.

when we come to the more extensive experiments of Cattell and Farrand upon male and female University students, we find that the average error for the F below the middle C was over a whole tone, which (after making all possible allowances for diversity in procedure; both experiments were conducted on monochords) must be taken as at least twenty times worse than the results of Delezenne.[1]

This and similar apparent discrepancies, however, seem to proceed from a too vague and also too narrow conception of "Practice." Many writers freely make assertions concerning "highly trained reagents" (geübte Versuchspersonen) without stating — often, it would appear, without clearly realizing — whether the latter are merely trained in music generally, or have had special practice in distinguishing minute differences of Pitch. Other authors, on the contrary, term all their subjects "unpractised," even though accomplished musicians, if they happen to be new to this particular experiment; in such sense must be taken Delezenne's designation "les oreilles les moins exercées," for his reagents seem from the context to have been distinctly above the average as regards general musicality. Now, though the hyperacute sensitivity characterizing the acousticians has *not* been found (by the present writer at least) in most musical performers, even professional, yet the latter are at any rate considerably superior to the average person. Thus we so far have three very distinct grades of training: acousticians, musicians, and the rest.

There is also another kind of practice that must always be duly considered, namely that gained during even brief experiments. The Columbia undergraduates, for instance, who had a monochord put into their hands and were told to forthwith adjust it so as to produce unison with a previously given note, were, as regards training, almost as far removed from subjects whose examination lasts a quarter of an hour, as these again are from the long exercised reagents of Stumpf, Luft, etc.

Lastly, there is a factor which though analogous to Practice yet must not be too summarily identified therewith; this is the influence of General Culture. It will require discussion in some detail, as it does not seem to have hitherto gained much attention, since it is peculiarly liable to engender fallacies in comparative tests of children's discrimination, and may eventually prove of profound theoretical importance. A glance at Table V will present a very marked inferiority on the part of the villagers as compared with the better social classes, for the former have a threshold more than twice as great as the latter. Small as is the number of cases involved, the discrepancy is so

[1] Psych. Rev. Monograph Supplement, June, 1901.

large as practically to exclude mere accident.[1] The next readiest explanation is that villagers have far less opportunities of hearing music. But nearer investigation does not very much confirm this view; for the village in question rejoiced in the possession of an unusually fine set of church bells, and whoever has listened to a band of sturdy yeomen singing for eight consecutive hours through all the possible "changes" will realize that those in the neighborhood have ample opportunity of hearing musical intervals. (The present writer had the misfortune to reside within a few yards of the said church.) Moreover, with one exception, all the villagers examined were in the habit of singing at home; while two of them were no mean performers on the violin and organ respectively. The violinist, it is true, exhibited the same discrimination as the average good musician; but the organist formed no exception to the general obtuseness, other than a far quicker capacity for improvement.

The same phenomenon is equally conspicuous among the young; for the village children, in spite of regular instruction and practice in singing, had a threshold twice as great as that found in the high class school. Also the relation between the children and the adults tells a similar tale; for in those social strata which continue after full growth to fully exercise their higher mental capacities, there is no appreciable alteration of ability to distinguish tones; the high class school has precisely the same average as the cultivated grown-up person. Among those, on the other hand, who at an early age are compelled to turn all their energy to muscular activities, we find a correspondingly rapid falling away of discrimination; bad as the child villagers were, those adult proved themselves nearly twice as inapt.

The only other experiments explicitly in this grade of society, with which I am acquainted, are the interesting ones of C. Myers;[2] and to these, without much straining, a similar interpretation may be given. His European village children (many of them possibly very young; unfortunately the ages are not shown) present an even lower average than those in Table I; that his adults slightly improve, while mine, on the contrary, go down, may well be attributable to the known habits of self-cultivation characterizing the Scotch peasantry. Myers' Papuan children, with only a smearing of alien education, are accordingly worse than the Europeans of any age or class; and on returning to the more congenial occupations of

[1] The improbability of mere chance works out mathematically to about 100 to 1 for this series of observations alone, not to mention the corroborative evidence of the children and other experimenters.

[2] Archives of Otology, XXXI, 4, 1902.

pearl-diving and cannibalism, their discriminative powers appear to sink lower still.

There is thus considerable evidence that the ability to discriminate pitch is largely affected by deprivation of General Culture. At the same time, this influence is only conspicuous in tests of an unfamiliar character; the villagers were incompetent at the—for them useless—task of distinguishing tones, but they show no inferiority whatever in the more practical faculties of telling one shade and weight from another. It would therefore seem that General Culture is not an independent factor that may be superadded to special sensory training, but no more than a possible partial substitute, just as the carbohydrates can excellently supplement but never supersede food-stuff containing nitrogen.

The various effects of all these degrees of Practice may now be expressed roughly enough, but still *quantitatively*, in the following tabular form: [1]

Median threshold for Discrimination of Pitch among adults.
(Expressed in v. d. for the two centre octaves.)

	Papuans	European Villagers	Non-Musicians of General Culture	Musicians	Specially Practised Reagents
With a minimum of fore-exercise.	—	30	10	4	½
After 15 minutes good fore-exercise.	16	8	4	2	⅓

[1] The Table appears to bring the various results of the best workers into very good harmony with one another and also with my own. It is regretted, however, that there is one exception to this general reconciliation; for it has been found impossible satisfactorily to accord the above estimates with a noteworthy series of experiments at Iowa in 1896, under the general direction of Seashore. There, the male University students showed a median discrimination of about 10 v. d., and the women one of about 9 v. d. These values, taking all things into consideration, appear at least twice as low as the analogous ones of Delezenne, Preyer, Gilbert, and myself. Moreover, it is even harder to reconcile Seashore's results from adults with his own simultaneous ones from children 10-14 years old; for the latter perfectly coincide with our table, showing a discrimination of about 4 v. d., and would therefore have double the sensitivity of the adults!

It must also be mentioned that Seashore arrives at a very different opinion from the above as regards the general effect of Practice. He

(*b*) *Sight*. In visual discrimination there is evidently less scope for further improvement by special training, seeing that the ordinary necessities of daily life are already sufficient to call forth a large portion of most persons' potential faculty in this respect.

But even here a considerable residuum of dormant power usually remains over and may be awakened on sufficient exercise. Schirmer,[1] for instance, found his threshold to continually diminish for about a week of continual practice, after which it seemed to him to have attained its maximum, while Müller-Lyer[2] and Simon[3] continued to make appreciable improvement for many months. Simon further noted the curious fact that practice in judging with both eyes brought with it but little betterment in judging with either eye alone; but when the left eye had been practised by itself to its maximum powers, then the right eye also, although itself unpractised, was nevertheless found to have advanced to its maximum. My own experience fully coincides with this view that the generality of people can considerably reduce their threshold by practice. Here, however, no appreciable influence is manifested by General Culture; the adults of the diverse social classes show just about the same average, and also as regards the children the difference is about what was to be expected from the difference in conditions of test.

This visual disparity between trained and untrained is difficult to estimate quantitatively. For previous experimenters upon unpractised reagents never seem to have attempted more than a rough empirical gradation incapable of being compared with other work. Our evaluation must therefore rest solely upon the present experiments, which, being conducted by daylight, are far from guaranteeing sufficient precision on this head; but still, as they turn out to agree perfectly with the mean of previous records of trained reagents, in all probability they are approximately accurate as concerns untrained ones also. In this case, the median threshold for discrimination of medium shades of gray, after 15 minutes fore-exercise, may be taken as involving the following difference of luminosity:

Untrained Reagents	Trained Reagents
1/30	1/120

holds that neither musical education nor special training can materially affect most people's power of discriminating, and he supports his view by inquiries instituted among the parents of his children and also upon a few experiments.

[1] Arch. f. Ophthalm., XXXVI, 4.

[2] Arch. f. Anatomie u. Phys., 1889, Phys. Abth., Supplementband, p. 96.

[3] Zeit. f. Psych. u. Phys., Vol. XXI, p. 433.

It would thus appear that in this faculty the influence of training is considerable, but still only about one-third of that in discrimination of pitch.

(*c*) *Weight*. Here, curiously enough, Practice seems to have remarkably little effect; the most highly trained experimenter has shown no advantage over the first comer.

Weber, for instance, declares 1/40 to be the difference just distinguishable by "quite the majority of human beings, without any long preliminary practice;"[1] yet he himself, in spite of all his long labors, appears to have been much below this standard.[2] Similarly his successor, Fechner, after prodigiously extensive training, was in the end but a very moderate performer.[3] A more direct proof of the inefficacy of prolonged exercise is given by the case of Biedermann and Loewit; for these observers at the very beginning of their experiments found their threshold for one-half pound to be equal to 1/21; yet at the close of their protracted research, this threshold had only improved to 1/23.[4]

But however true this may be as regards training of very great duration, I have convinced myself that it does not hold good as regards the few minutes of fore-exercise; for my reagents have almost invariably discriminated better at the end of their fifteen minutes than when they first entered the room; sometimes the improvement is enormous.

We come, therefore, to the general conclusion that a few minutes' practice are necessary for most people to accustom themselves to the test, but that further training has little or no effect.

(*d*) *Intelligence*. As to the effect of training in this direction, there unfortunately appear to be no available data, except such conclusions as issue from the present experiments themselves. All that could be done before commencing work was to contrive that the reagents should, as far as possible, be on equal terms with regard to previous education.

4. *Irrelevancies from Age*.

This factor is obviously one that must largely influence both Sensory Discrimination and Intelligence, since nobody can suppose that any mental faculties remain at one constant level from first birth to the prime of manhood and on through the last senile decay. The matter acquires peculiar importance owing to the practical reason that we find it much easier to

---

[1] Tastsinn u. Gemeingefühl, p. 541.
[2] Annotationes anatomicae et physiologicæ, Prol. XVII.
[3] Psychophysik, Vol. I, p. 186.
[4] Berichte d. kais. Akademie d. Wissensch. zu Wien, Math. Naturw. Classe, Vol. LXXII, p. 343.

subject children to our experiments than to induce the same number of adults to let themselves be tested. Consequently, every research of this kind so far has dealt exclusively with reagents not yet beyond adolescence. We will again consider each of the four variants in turn.

As regards *Pitch*, the first notable inquiry into the development of discrimination appears to have been that of Gilbert, who comes to the conclusion that from the age of six to at least that of seventeen years there is a continual though irregular improvement.[1] But the next investigator, Seashore, arrives at the very different opinion that no betterment takes place after ten, at which period he finds children to be fully equal to average adults; he even goes so far as to pronounce that "the organ of Corti reaches its maximum efficiency at the age of about ten, and that it then begins to deteriorate."[2]

By the light of the previous section, however, it seems possible satisfactorily to reconcile these very divergent results. For we have just seen the immense effect of Practice, especially in this matter of pitch, and we may not unreasonably suppose such faculties to arrive at maturity earlier or later according as they have been more or less fostered by education, special or general. This hypothesis will be found frequently corroborated in the present work. The high class school perfectly harmonizes with Seashore's elder children in presenting no further increase of capacity after nine, at which age the average threshold already equals that of adults; and this agreement with Seashore extends not only to the relative powers but even to their absolute performances, for both lots of children show a mean of about 4 v. d. But when we turn to the villagers, then the accordance is no less entirely with Gilbert: from 5½ to 7 years, they average 40 v. d.; from 7 to 8, 23 v. d.; from 8 to 10, 15 v. d.; and from 10 to 14, 6-7 v. d.; and here again also the absolute values fairly coincide with Gilbert's, although the latter used such a different testing instrument as an adjustable pitch-pipe.

Even into very advanced life, the influence of Age appears still interflected with the previously mentioned factor of Culture. For those adults who exercise their higher intellectual functions abide to almost the end of their days at their best level; nothing is observable to correspond with the generally believed diminution of their audible range from 11 octaves to 10. To myself, it was no small surprise to find that the persons of 60, 70, and even 80 years could discriminate quite as acutely as those in their physical prime. But among the grown-up villagers there seems to occur a marked bifurcation: those

[1] Stud. Yale Psych. Lab., 1893. [2] Stud. Psych. Iowa, Vol. II.

of them who on leaving school take to violin playing, hand-bell making, etc., continue to develop the discriminative function until it eventually becomes quite as fine as if it had enjoyed a better start; but those who have not had such special later advantages will not be saved by occasionally hearing music from lapsing into great dullment.

Turning next to *Sight*, Gilbert's very extensive experiments again present a continual growth perceptible even up to the seventeenth year; between nine and fourteen, the ages chiefly entering into the present work, the average threshold becomes reduced by about one fourth. My own results turned out quite similar as regards the village children, but in the higher class school development appeared to occur earlier. With respect to Old Age, this again appeared to bring with it no impairment whatever; the supposed "sharpness of young eyes" did not make itself manifest.

In respect of *Weight*, Gilbert's curves show a somewhat quicker arrival at maturity, no improvement being evident after about thirteen years old.[1] The present experiments quite concorded in that the younger children were almost equal to the older ones and both were not far from adults. In Old Age, we once more find no appreciable loss of power.

Finally, we come to the effect of Age upon Intelligence. On this matter general opinion seems to be sharply divided; for some assert that, other things equal, a child must necessarily get cleverer as he grows older; while others hold Intelligence to be equally manifest at all ages after infancy and to be easily distinguishable from the gradually amassing stock of acquirements and proficiencies. As before, in default of any positive antecedent data the present experiments could only keep the point in view and endeavor themselves to throw light upon the question.

5. *Irrelevancies from Sex.*

This factor evidently requires consideration, seeing that in some of the previous experimentation males and females have been thrown together without apology, while at other times these have been regarded as obviously heterogeneous to one another.

Commencing with children, the only important evidence concerning *Sight* and *Weight* seems to be that of Gilbert,[2] who comes to the conclusion that the sexes not only differ but that this disagreement is a quantity perpetually fluctuating from year to year according to the various phases of growth and especially of puberty. As regards *Pitch*, the chief testimony is

---

[1] Stud. Yale Psych. Lab., 1894, p. 59. [2] *Ibidem*, p. 57.

that of Seashore, who declares boys and girls to present not the least appreciable difference.

Now, it is very improbable that the various senses should really be so unlike in such a respect, and accordingly it was not surprising to find that in the present experiments the village boys and girls showed quite analogous differences in Pitch also. Perhaps Seashore's results may be reconciled in the same way as before, that is, by considering that his children appear to have been better educated generally and therefore to have passed beyond the perturbations characteristic of the growing phases.

With respect to the influence of Sex upon adults, Seashore's women present a slightly better discrimination, but the difference is only such as may well be attributed to their more general study of music at the age in question. My own results coincided, in that both sexes appeared perfectly equal in all three senses tested; no support whatever was given to the popular assertion that men are much superior.

6. *The Elimination of these Irrelevancies.*

Thus we have come upon a considerable number of factors which evidently disturb the relations that we are about to investigate; and the more we sharpen our criticism, the smaller aberrations shall we be able to bring to light, until the latter begin to appear infinitely numerous and hopelessly unavoidable; we successively encounter illegitimate deviations proceeding from hour of test, from temperature, from fatigue, from state of health, from fullness of stomach, from habitual and occasional consumption of alcohol and caffeine, and so on without end. Eventually, our experimentation will arrive at the condition of the hysterical person who has found out some or other medical objection to every description of food — and so dies of self-starvation. To undertake any investigation at all, our attention cannot be confined to the detection of these impurities, but must take the further step of ascertaining which of them we can and cannot afford to neglect in practice. With this view, we have in every case insisted upon obtaining *quantitative* estimates of the differences actually produced by the various intruders, and we have found them to vary from the extravagant proportion of 1:60 down to inappreciability; from these general computations, it will usually not be hard approximately to pick out the amount applicable to any particular experiments.

So far, however, our information is still almost worthless. For the perturbance into which we are inquiring does not depend simply from the above average difference produced in the measurements by the intruder, but upon the *ratio* of this special

difference to the total average difference found in an assemblage of individuals from both the disparate classes; this latter difference will clearly be the greater of the two, seeing that it derives from many other differentiating causes in addition to the special one; the ratio will very approximately present the correlation between the disturbant and the term disturbed.[1] Even yet, though we have thus obtained all the requisite data, we cannot utilize them to measure the perturbance until we have further obtained a mathematical equation capable of performing this office; this will be given at the end of the next chapter; by its aid and that of the foregoing inquiry, we are finally enabled to decide which of the irrelevancies produce a falsification of appreciable size as compared with the probable error; all of less magnitude may be left out of consideration, as their elimination would not be of the slightest practical advantage.

To avoid more tediousness, we will here take only two sample cases to illustrate how the decision is actually reached as to whether an irrelevant factor be really of formidable nature. In tests of Pitch, say, it is desired to know whether the reagents may properly consist of non-musicians, mixed with musicians. Our Table (page 231) shows us that the former have an average threshold about twice the size of that of the latter; next, on taking a number of thresholds of both non-musicians and musicians thrown together, we find that the ratio between the averages of the worse and better halves respectively comes to something very near 3:1 (see any of the quoted works); hence the irrelevant correlation is about 2/3 or 0.62. Applying the appropriate formula, we find that under such circumstances a real correspondence of say 0.50 would be unduly deflected by about 0.14. As the experiments were being designed on such a scale as to give a probable error of only about 0.03, the perturbance must be pronounced very appreciably falsifying.

Let us consider the analogous case as regards the sense of Sight. Here also, it may safely be assumed that diversity of daily occupation among the reagents will have led some more than others to practise this particular faculty, and further that the extent of this discrepancy will on the whole certainly be less than that between musicians and non-musicians (seeing that very few people spend hours a day in discriminating small variations of light and shade); again, the general effect of practice in this sense has been found to be about one third of that in Pitch (p. 232), while the total average difference turns out to be about the same as for the latter; hence this time, the irrelevant correlation will be at any rate much less than one

---

[1] See "The Proof and Measurement of Association between Two Things." This *Journal*, Vol. XV, 1904, pp. 72-101.

third of 0.62. On once more applying the suitable corrective formula, we find that any irrelevant correlation of 0.21 would falsify a real correspondence of, say, 0.50 by an amount of only 0.01. Thus we have ascertained that the deviation caused by difference of Practice is in this sense not likely to affect our result by more than a very small fraction of the probable error and may well be neglected.

In this way, a large number of irrelevant factors may be summarily dismissed from consideration; others, either from their amount or from the doubtfulness of the evidence concerning them, must be carefully kept in view; while some will be found of an unquestionably falsifying nature. The first employment of our knowledge is so to order our experiments from the beginning, both as regards selection of reagents and procedure in testing, that appreciable perturbance may be escaped. Next, and yet more important, we have learned the directions from which serious danger is to be apprehended, and forewarned is forearmed; we are enabled to so conduct our work, that the residuum of deviations which could not be excluded actually may instead be afterwards eliminated with mathematical exactness from the final results.

7. *Alternatives and Equivocalities.*

Notwithstanding the exhaustive selective process which will have had to be executed in order to sufficiently eliminate all these irrelevant factors, there will generally still remain over a certain number of experimental methods that at first sight appear almost equally eligible.

As regards Intelligence, to begin with, there is a considerable variety of ways by which estimates can be gained, and most people would appear to enjoy very decided views as to which are the most satisfactory; but since the convincement of their opinion usually stands in inverse proportion to its evidential value, it is perhaps safer to begin with the methods nearest to hand and gradually discover for ourselves their relative advantages. In doing so, two points must always be carefully kept asunder: first, the *reliability* with which any system of measurement represents any particular form of intelligence; and secondly, the claims of the said form of intelligence to merit the name. The former point must be definitely ascertained in the course of the experiments, while the latter, though a very desirable piece of information, may or may not be eventually elucidated by the whole Investigation.

Sensory Discrimination will usually offer a still greater field of choice. About the mode of interrogation, it here need only be mentioned that the present wants are not necessarily identical with those of other psychological work. For instance, it is

well known that the sensory threshold has really two different values, according as the examination proceeds from greater to less differences or *vice versa;* now, for questions specially concerning this threshold as such, it is desirable to take the mean between the upper and lower values; for the present purpose, on the other hand, more regular results appear obtainable in a given time by determining only the lower threshold (the reason seems to be that the reagents become less confused when the changes are confined to the one direction).

Then comes the question as to what precise portion out of the whole sensory range should be chosen as the theatre of our experiments. For our pioneering work, at any rate, it would appear unquestionably best to commence with that part where the results are least exposed to irregularities, complications and unknown factors; this will always lead us to somewhere near the centre of the range.

Lastly, we must consider the influence of different apparatus. It is a much more prominent factor in some senses than in others. In Pitch, it appears to be minimal; highly trained observers, however variously tested, show little more diversity than can be satisfactorily accounted for by individual disposition. Delezenne,[1] Seebeck,[2] Weber,[3] Preyer,[4] Appunn,[5] Stumpf,[6] Luft,[7] and Meyer,[8] though using such widely differing instruments as monochords, reed-pipes, and tuning forks, obtained results of which the largest is little more than double the smallest, and even this small difference appears chiefly attributable to difference in mode of interrogation. Among less practised reagents, indeed, sensibility will sometimes be found to vary enormously with the kind of timbre, one person doing much better when there are no appreciable overtones and another *vice versa;* but still such discrepancy is generally traceable to diversity of previous habit and continually diminishes with further training. In Visual Discrimination, the results have been considerably less uniform. It is true that the majority of competent observers, Kraepelin,[9] Volkmann,[10] Aubert,[11] Masson,[12] Merkel,[13] etc., though employing such various in-

[1] Recueil des travaux de la soc. de Lille, 1827, p. 4.
[2] Poggendorf's Annalen, Vol. LXVIII.
[3] Pogg., XIV.
[4] Die Grenze der Tonwahrnehmung.
[5] *Ibidem.*
[6] See ref. to Meyer, note 8.
[7] Wundt's Phil. Studien, Vol. IV.
[8] Zeit. f. Psych. u. Phys., Vol. XVI.
[9] Wundt's Phil. Stud., Vol. II.
[10] Fechner's Psychophysik, Vol. I, p. 148.
[11] Physiologie der Netzhaut, 1865, p. 58.
[12] Ann. chim. phys., 1843.
[13] Wundt's Phil. Stud., Vol. IV, p. 566.

struments as Masson's disc by daylight, the same by artificial light, the shadow-method, the episcotister, and illuminated matt glass—all agree that the most favorable medium shades of gray can just be distinguished from one another when the illumination differs by about 1/120. But on the other hand König with Brodhun,[1] Helmholtz,[2] and Bouguer[3] arrive at a threshold twice as big, while Schirmer[4] and Volkmann (in his later experiments) come to one nearly twice as small. That, however, the lion's share of these dissimilarities may be solely attributed to difference of instrument is shown by the largest variation occurring in one and the same person: Simon, when using the platinum lamp of König, has a still worse threshold than the latter; but when employing a disc like Schirmer, surpasses even this observer. The discordance assumes far greater proportions when we come to Discrimination of Weight: for widely apart are the values successively obtained by Weber,[5] Fechner,[6] Biedermann and Loewit,[7] Hitzig,[8] Jacoby,[9] Merkel,[10] Müller and Schumann,[11] Martin and Muller,[12] etc.; on the one extreme we have Biedermann and Loewit who could clearly perceive a difference in a 2 lb. weight if it were increased or diminished by so little as ½ oz.; on the other side, we find C. Jacoby whose five thoroughly trained and competent reagents required for the same purpose an increase or reduction *twenty-four* times greater, a discrepancy that for the main part may safely be attributed to difference of apparatus.

This multitude of gross fluctuations requires careful analysis. A certain number merely imply greater or less difficulty in the performance and consequently a simultaneous rise or decline for the generality of reagents. Others, again, derive from difference of individual disposition; the larger these are in any procedure, the more accurately will any functional correlation be able to be calculated; but they must not be too summarily confounded together, for possibly one procedure may exhibit greatest sensitivity to previous practice, while another may be the most delicate barometer of fatigue or ill health, and yet a

[1] Sitz. Ber. d. Berl. Akad., 26-7-1888 and 26-6-1889.
[2] Physiol. Optik, p. 315.
[3] Aubert, Phys. Optik, 488.
[4] Arch. f. Ophthalm., Vol. XXXVI, p. 121.
[5] Tastsinn u. Gemeingefühl.
[6] Psychophysik, Vol. I.
[7] Berichte d. kais. Akademie d. Wissensch. zu Wien, Math. Naturw. Classe, Vol. LXXII.
[8] Neurol. Centralblatt, 1888.
[9] Arch. f. Path. u. Pharmak., 1893.
[10] Phil. Studien, V.
[11] Pflüger's Arch., XLV.
[12] Zur Analyse der Unterschiedsempfindlichkeit.

third may reveal the largest correlation with intellect. The remaining fluctuations derive from causes so obscure, that for the present we must call them chance irregularities tending only to shroud and disguise our results.

From these considerations, it is clear that an alteration in method of experiment may result in transforming the correlation. But this further complication, far from being a real disadvantage, opens out a rich and virgin field to investigation, for it is the most promising means of penetrating into the correlation's essential nature. Eventually results will be gained of such greater generality, that they will stand out constant among these superficial changes, as the main features of a landscape abide immovable in the passing variety of cloud and sunlight.

CHAPTER IV.

Description of the Present Experiments.

1. *The Choice of Laboratory Psychics.*

We will now turn to a description of the experiments that form the basis of the present article. Their many deficiencies can scarcely be clearer to any one than to their author; so true is it that we first learn how properly to conduct any experiment—when we have ended it.

As regards the nature of the selected Laboratory Psychics, the guiding principle has been the opposite to that of Binet and Ebbinghaus. The practical advantages proffered by their more complex mental operations have been unreservedly rejected in favor of the theoretical gain promised by utmost simplicity and unequivocality; there has been no search after condensed psychological extracts to be on occasion conveniently substituted for regular examinations; regardless of all useful application, that form of psychical activity has been chosen which introspectively appeared to me as the simplest and yet pre-eminently intellective. This is the act of distinguishing one sensation from another.

With respect to the particular senses preferred, the present experiments have been confined to Hearing, Sight, and Touch. The other five, Taste, Smell, Pain, Heat, and Cold, do not admit of such practicable or satisfactory examination; also, probably on this account, they have as yet been investigated very incompletely, and therefore do not form a good unequivocal foundation for research of more advanced order. Further, in the chosen three we have already the widest range of type: for Touch is the most direct of the senses, the physiological organ being apparently of such a simple structure as to convey

the stimulus to the brain in a purely mechanical manner; Sight, on the other hand, offers the most perfect example of peripheral transformation, seeing that our visual presentations are but very remotely derived from the really external ether waves with which they are popularly confused; while Sound gives us a half-way stage between the above extremes.

In all three cases, the test has been of relative, not of so-called "absolute," Discrimination; the trial has not been as to how small an external stimulus can cause a sensation perceptible at all, but as to how great the difference in the external stimuli has to be for the reagent to notice any difference in the sensation; every one knows the uncertainties attending the former kind of investigation. Similar motives have in Sound made Pitch seem preferable to Intensity; and in Light, Luminosity to Color. It is perhaps less easy to justify Touch being represented by that form of it often termed the "muscular sense," which despite its notoriety and historical importance is now well known to be really most complex and obscure.[1] Among other reasons for this choice, it was desired to see whether any correlation of Discrimination with Intelligence might not reasonably be attributed to adroitness in outward approach to the distinguishment rather than to superiority in the essential act itself; should this be the case, then the correspondence should be much more manifest in an active practical comparison of two weights than in the purely passive acceptance of two tones.

In short, the experiments were so chosen that any conclusions very uniformly attained in these three ways might be provisionally considered to hold good for Sensory Discrimination in general.

It may here be remarked that the present experiments were not primarily designed and executed for the sake of Discrimination itself, but as the indispensable basis for an investigation into Memory and Imagery. Only afterwards was it decided to publish the results on the former head separately, so as to keep the present article within manageable length and at the same time to secure for it greater unity and lucidity.

2. *The Instruments.*

The apparatus with which these inquiries were conducted were not of a very new or elaborate nature, my object at present being merely to make a practical and convenient application of the existing laboratory methods. Moreover, while naturally

---

[1] It is here by no means intended to assent to the identification of the feeling of Effort with any combination of touch sensations, but only to admit that the former is in practice chiefly estimated through the mediation of the latter.

endeavoring to minimize all errors proceeding from mechanical imperfection, I have become quite convinced that faults arising from such a cause are in this case vanishingly small as compared with those proceeding from other sources.

(*a*) *Sound*. Like the experiments of Delezenne and Cattell mine were conducted by means of a monochord, but of a special kind made under my direction for this purpose; it is furnished with a Vernier scale, whereby differences of pitch can readily be produced down to ⅓ of a vibration; as the experiments were limited to the immediate neighborhood of the E above the middle C (reckoning the latter at 330 vibrations per second), the smallest securely obtainable difference amounted to 1/132 of a musical tone.

To the accuracy of such an instrument many theoretical objections may be raised, as unevenness of the wire, inequalities of tension, etc. However, experience has shown it to be reliable to the range above mentioned, which is ample for the present purpose. It was first tested in the usual way, that is, by simultaneously sounding two notes at a given small interval and then counting the interferences in the sound-waves; I had no difficulty in producing good reliable "beats." The instrument has further been well checked empirically, for more than one reagent has proved able correctly to discriminate down to the extreme limit. I have also been fortunate enough to obtain assistance in this manner from Dr. Krüger; this psychologist and acoustician very kindly allowed himself to be tested with my machine and found his threshold to be only such a small amount greater than with tuning forks, as would naturally arise from his having had much more practice with the latter instrument.

The principal crime generally charged against monochords is that they give far stronger overtones than do tuning forks and that consequently tests upon the former may not be comparable with those upon the latter. This point has already been discussed, and our conclusion was that all the different instruments hitherto tried had led to very similar *average* thresholds (in this respect being very unlike discrimination in Sight and Weight). In any case, there is no reason whatever to suppose that the results given by the overtoned instruments are at all less regular, and this is here the only matter of importance.

As a set-off against this one merit of comparative freedom from overtones, tuning forks are in so many other respects difficult to manage, that I should not personally prefer them except for use in an exceptionally well equipped laboratory. To bring them to sound, they have to be either struck with a hammer or stroked with a bow, and the consequent accessory

noises and tones can hardly be reduced to such a minimum as is easily attainable in plucking the monochord; also, the tone from the fork only remains constant for a very short time, after which it rises very deceptively; further, it is very difficult to obtain two tones of sufficiently equal loudness, without using a special striking apparatus which again involves other disadvantages. Moreover, it is almost impossible to obtain enough range of tone in any satisfactory manner, especially as even the best tuning forks have appreciable overtones unless placed upon resonators to preferentially intensify the ground-tone; the device of a different fork for each grade of pitch is of very dubious merits; and when the common custom is followed of using one fork with the sliding regulator on it while the other has none, the overtones become so dissimilar as frequently to vitiate the whole experiment. The last objection can be partially met by having on each fork a separate regulator very light and low; but the first and second difficulties are very insufficiently overcome by the usual expedients, such as moving the fork to and from the reagent's ear; to fully obviate them, it is at least necessary to be able to conduct the sound from one room to another, so that the experimenter remains with his forks and opens the conductor just when the tone is pure and true, while the reagent sits alone and hears only what he is intended to hear; but such a procedure is quite inapplicable to the inexperienced subjects requisite for experiments like the present ones.

(*b*) *Light.* As we have seen, a great number of instruments have been at different times used for this purpose. Each of them possesses various advantages and disadvantages of its own. For my purpose, I constructed a graduated series of cards, each being slightly darker than the preceding one. The required delicacy was obtained by photographic means, on the principle that the darkness of a print will (for a certain short range of half-tints) vary almost proportionately to the time of exposure to light. Various ways of printing were tried; silver gave a very fine gradation, but necessarily introduced the disturbing element of color; carbon was found difficult to develop with sufficient evenness; final preference was given to platinum on the smoothest possible paper, and a series of prints were obtained of such differences that the extreme ranges would measure the dullest normal sight, while two neighboring cards could not be distinguished by the acutest vision.[1] The prints, each about 2″ by 1″, were then mounted on smooth cardboard, num-

[1] This method of constructing cards as visual tests seems to have been very minutely anticipated as long ago as 1896 by Marbe (see Zeits. f. Psych. u. Physio., Vol XII, p. 62).

bered on the back, and given a border about one inch wide of even black, so that the conditions of contrast should in all cases be approximately equal.

The evenness of the series was then tested practically on many reagents, by trying whether all pairs of cards at the same number of grades apart presented precisely the same difficulty of distinguishment.

As to the illuminating source, it unfortunately was not found practicable to conduct the experiment by the uniformity of artificial lighting. However, small differences of the absolute intensity of the illumination are known not to appreciably affect accuracy of judgment, and such was found to be actually the case as regards the inevitable minor fluctuations of daylight. The most important point was that the two cards to be compared should be illuminated to exactly the same degree. This was sought by placing them side by side on precisely the same plane and opposite the centre of an evenly lighted window. Most reagents had a marked inclination to consider one particular side darker; in some cases this was the right, and in others the left (I could not find that this tendency corresponded with right and left handedness respectively, as might perhaps have been expected in view of the experiments of Van Biervliet[1]).

The general luminosity of the cards was determined in the following manner. The lightest and darkest were placed in a dark room, and two candles were arranged in front of them in such a way that each threw a circular ray of light about one inch in diameter upon one of the cards. It was then experimentally ascertained how much closer to the illuminating source the darker card had to be, for the latter to appear just as light as the other. The square of the greater distance divided by the square of the lesser thus gave a measure of the relative brightness of the two cards under equal conditions. It would be superfluous here to enter into the various details adopted to make this test satisfactory, seeing that the result is at best only roughly approximate; for, among other things, the luminosity was thus tested by artificial light, while the discrimination was tried by the different luminosity and tint of daylight. Within the actual limits, however, it does not appear that the consequent error will be very considerable; hence, the value found seems sufficiently accurate to be of some interest, especially as it is difficult anywhere to discover quantitative estimates of the normal unpractised person's power to distinguish differences of light.

(*c*) *Weight*. For this test a graduated series of weights were

[1] L'asymétrie sensorielle. Bulletins de l'Académie des Sciences de Bruxelles, Vol. XXXIV, Série III.

constructed on Galton's convenient cartridge pattern,[1] all of precisely the same size, appearance, and balance; the lightest was 1,000 grains, and the others continually increased their weight in geometrical proportion. I found it necessary to considerably extend the range of differences; for some of my reagents could accurately distinguish Galton's finest degree, namely 1/100; while many perfectly normal persons showed an obtuseness that could not be measured even on the extremes recommended by him as being adapted for "morbid" cases.

3. *Modes of Procedure.*

(*a*) *Experimental Series I.* The reagents were the twenty-four oldest children of a village school in Berkshire, taken without any selection; they were tested in Light, Weight, and Sound. This school was particularly favorable for my purpose, as it was within 100 yards of my own house; all the children and their families resided in the immediate neighborhood, so that I could easily obtain any information concerning them; the rector and schoolmaster most obligingly gave their valuable co-operation, for which I hereby tender hearty thanks.

Each child was separately interviewed in my house, on a different day for each different sense. The test of Discrimination lasted fifteen minutes (and was then followed by test of Memory; the coincidence between these two is a good measure of the accuracy of both). No single trial was ever unusually prolonged, for fear of admitting the disturbing effects of fatigue, but further interviews were obtained when any doubtful points seemed to require clearing.

As regards the manner of interrogation, there was little hesitation in rejecting the method known as "minimal changes" in its purer form, which is dependent upon the reagent saying whether or not he can distinguish the difference between the two sensations offered to him; such a procedure appeared totally unfitted for such inexperienced persons. But still less applicable appeared the strict method of "right and wrong cases." The compromise was therefore adopted of searching for that threshold where the subject seemed able to give about 80% of his answers right. For similar reasons, preference had to be given to the "procedure with half knowledge" (halbwissentliches Verfahren) in spite of certain disadvantages;[2] in this, the reagent is informed that the two stimuli are different, but is left to decide for himself as to the direction of the difference.

The beginning of the test is not devoted to recording the largest possible number of answers, but to quietly affording

[1] Inquiries into Human Faculty, Appendix.

[2] See Kämpfe, Wundt's Phil. Stud., Vol. VIII.

the reagent a maximum of fore-exercise and at the same time to gaining a general idea of his threshold. Then, there is a steady progression from greater to smaller intervals, until eventually a threshold is found where he can just give eight right answers out of ten. He is further tried at a still smaller interval, to see if he makes still more mistakes and thus to confirm the fact that he has really reached his limit. And finally he is once more tried at a slightly larger interval than the believed threshold, to corroborate the former observation that he here makes less than two errors out of ten. This constant progression in only one direction appears to very much reduce the mental distraction especially inherent in all procedure "without knowledge," which is very great in unpractised reagents if tested with the usual oscillations to and fro between greater and smaller intervals. Against it may be urged that it finds only the lower instead of the mean threshold, but this is of no importance for our present purpose.

It was further considered that more regularity would be obtained by only recording those answers which were given under the most favorable conditions. Before taking down each reply, a chance of reconsideration was given by repeating the test in such a manner as to reverse the constant error of time and space.

The two stimuli followed one another in the manner found to be most adapted to accurate judgment and to effectually eliminating the influence of Memory. In the case of pitch, the interval from the beginning of the first tone to that of the second was found best at about three-quarters of a second. In some earlier experiments, the first tone was just dying away when the other began; but later, I stopped the first one altogether just before giving the other. There is some knack required to do this satisfactorily, and the practical effect of the change was, to my own surprise, inappreciable with most reagents.

The final measurements, just as they were obtained, are set down in the column under "Sensory Threshold" in Table I.

(*b*) *Experimental Series II.* This was executed in the same village school, but upon the next thirty-six oldest children, the tests being only in sound. Unlike the previous twenty-four, these were examined collectively, the total interview lasting about 1½ hours. The chief part of this time was devoted to instructing and practising them, and to finding out what was the lowest age fit for such a collective experiment. It became eventually evident that no usable results could be obtained at any rate from those below 5½ years, and thereupon all those under this age were excluded, leaving thirty-six for the real tests.

The latter were carried out in the following manner. Every

boy and girl was provided with a pencil and a piece of paper and had simply to write down 1 or 2, accordingly as he considered the first or the second tone to be the higher. The headmaster as well as the other teachers were present; a small prize was offered to stimulate attention, and energetic measures were found necessary to prevent cribbing. Ten test pairs of tones were given at about the following eight differences of pitch, 50, 33, 26, 20, 16, 10, 6, and 3 v. d.; thus in all, each child answered 80 times; in half the cases, the first tone was really the higher, and *vice versa*.

The marking was done by fully considering each child's whole paper, and then deciding as to what was the limit at which he might be expected to give about eight right answers out of ten. This method has seemed to me in such cases the most satisfactory, provided that the person marking has acquired the requisite experience by having previously examined in a thorough manner a great number of similar reagents, and provided the marking of the paper be done before receiving the intellective gradings (or else there is a great danger of "self-suggestion"). If this method be not adopted, recourse must be had to some purely formula reckoning of errors.

Despite all precautions to secure reliable results, I was unable to quite convince myself that such uncultured children could be treated adequately without elaborate individual attention.

(*c*) *Experimental Series III.* These experiments — confined to Sight and Weight — were made in a preparatory school of the highest class, which principally trained boys for Harrow. To the Principals, themselves old Harrovians, my hearty thanks are due for their kindness and cordial co-operation. As may well be imagined, the social standing and general culture of the reagents were the opposite extreme to that in the village school.

Unfortunately, these tests of Light and Weight had to be arranged at a few hours' notice and consequently were carried out under very unfavorable conditions. Out of the thirty-seven boys constituting the school, only twenty-four could be present, and of these again it was necessary to withdraw one from the results as being mentally too abnormal to be properly included with the others. In the next place, no masters were in the room after the first few minutes; in spite of the general excellent behavior, this relaxation of discipline must always be admitted to be a momentous circumstance. And finally, the visual and muscular senses—never well adapted to collective examination—had on this occasion to be tested with the apparatus intended only for individual work: the weights and the cards were continually passed round and round by pairs, ticketed 1 and 2 respectively; each boy then wrote down which of the two he considered to be the heavier or darker.

It was impossible to control whether they all handled the apparatus in precisely the same manner, or even to insure that they invariably gave their greatest possible attention to their tasks; moreover, some were inevitably more favored than others as regards intensity and evenness of illumination.

Owing to these facts, I brought away the impression that the experiments were chiefly interesting as enhancing the effect of *Goodwill*. For under better conditions, every reagent can be brought pretty well to try his best; but here, on the contrary, a wide range was observable in this respect, some being very zealous while others were visibly indifferent.

(*d*) *Experimental Series IV*. This series, which was in Sound only, took place in the same high class preparatory school, but now the circumstances were as propitious as above they were the reverse. Pitch is a sensory quality especially susceptible of collective test. The experiments were arranged and prepared with full deliberation. The entire school were available with only the exception of the above mentioned abnormal case, of one boy who had to leave the room before the end of the hour, and two who were that day absent; thus there were thirty-three complete results. Several masters attended, so that the strictest discipline was maintained throughout; there appeared no inclination to crib; every boy seemed perfectly to understand what was required and to be intent upon doing as well as possible. I am therefore inclined to attach as much value to this series as to Series I; for the cultured intelligence and long habit of examination possessed by these boys should compensate the individual attention given to the villagers.

The conditions entirely resembled those described in Series II, except that only 48 final tests were made, 6 at each of the following differences: 20, 15, 11, 8, 6, 5, 3, and 1 v. d. The intellective grading was not received by me until long after the sensory grading had been completed, so that the latter is free from danger of self-suggestion.

(*e*) *Experimental Series V*. These were executed upon 26 male and female adults (thus bringing the total number of reagents throughout the present experiments to 123).

The method was individual and precisely the same as that already described for Series I. But in arranging the composition of the reagents, instead of trying to obtain as homogeneous a set as possible, it was here rather sought to include the greatest variety; for although little can be proved in such a manner, much can profitably be suggested.

4. *The Estimation of "Intelligence."*

As regards the delicate matter of estimating "Intelligence,"

the guiding principle has been not to make any a priori assumptions as to what kind of mental activity may be thus termed with greatest propriety. Provisionally, at any rate, the aim was empirically to examine all the various abilities having any prima facie claims to such title, ascertaining their relations to one another and to other functions.

Four such different kinds of Intelligence have been introduced into the present work. First, there is that revealed in the ordinary classification according to school order (based here upon examinations). This clearly represents *Present Efficiency* in such matters as Latin, Greek, Mathematics, etc. Examples of this kind will be found in experimental series III and IV.

The next sort of Intelligence derives from the same school order, but so modified as to exclude all influence of Age. Such a corrected order may be provisionally accepted as representing, not Proficiency, but *Native Capacity*. It has been arrived at by taking the difference between each boy's rank in school and his rank in age. For obvious reasons, it has been preferred to consider the absolute and not the relative differences; a boy, for instance, who was 20th by examination and 22nd by age would be placed just above one who was 15th by examination and 16th by age, the former being two places and the latter only one better than would have been expected with greatest probability.

The resulting order is clearly but a first approximation, to which we may apply any number of further corrections. For our present purpose, the following has appeared the most that can be practically required (and even this makes no appreciable change in the final values obtained). Evidently, the top boy is prevented from proving his full capabilities by want of competitors; let us suppose that he happens also to be the oldest; then, on our above method, he will seem no better than a boy of middle age and at the same time of middle school order; but the latter will in reality always be found below many younger than himself, compensating this by being also above about an equal number of older ones; now, our top boy has not let himself be surpassed by any single one of his juniors, and therefore would certainly have gone above a great many of his seniors, had the school included such. The top boy's true position may be roughly estimated by making him an extra allowance of a number of places equal to the general mean deviation of actual from average rank (which in this case comes to 5 places); clearly, also, such allowance may with equal right be claimed by the top boy, even if he does not happen to be the oldest; further, the same correction is applicable in slighter degree to the second boy, in still slighter to the third, and so on in a

rapidly diminishing curve up to the centre of the school. For practical purposes, it has seemed sufficient to allow the next four boys, 4, 3, 2, and 1 places respectively; naturally, the whole of this correction must be repeated inversely for the bottom end of the school. Though this explanation is rather complicated, the correction is very easily carried out and, as stated, its effect is hardly appreciable.

3 The third kind of Intelligence is that represented and measurable by the general impression produced upon other people. This forms the basis of the common broad assortment of the children by their teachers into "*bright*," "*average*," "*dull*" respectively; and with such an assortment I have had to content myself for the elder children in the second series of experiments, while for those under 7 years of age, I have not obtained any intellective grading at all.[1] But for the more important Series I, a list of relative rank was procured of satisfactory completeness. It may here be noted that teachers, if directly asked for such a detailed list, frequently begin by asserting it to be impracticable. It will be generally found, however, that if they be merely requested to pick out the brighest pupil of all, they can do so without any great trouble; and when they are next requested to select the brightest of the remainder, they are still able to perform the desired feat; and so on, until the classification is complete.

4 The fourth and last sort of Intelligence which has here been estimated is that known as *common sense*. To this end, the oldest of the children of Series I was interviewed and interrogated concerning her comrades in precisely the manner described above, except that the criterion was not to be "brightness at school work" but "sharpness and common sense out of school;" and she seemed to have no great difficulty in forming her judgments concerning the others, having, indeed, known them all her life. As a check, and in order to eliminate undue partialities, it had been arranged that as she left the house, the second oldest child should enter it and thus be able to give an as far as possible independent list, since neither had beforehand had any idea of what was wanted. Finally, a similar list was obtained from the Rector's wife, who also had always lived in this village; but her graduation is unfortunately incomplete and therefore unusable, for she professed inability to pronounce verdict upon some few children who had not come much under her notice; as far as it went, it appeared perfectly homologous with the other two lists.

---

[1] The day after these experiments I left the neighborhood of the school.

5. *Procedure in Deducing Results.*

(*a*) *Method of Correlation.* So far this chapter has been occupied with obtaining estimates as to the reagents' respective abilities in the several sensory and intellective functions. This is an operation requiring the fullest use of psychological insight; and, therefore, based on the long preliminary investigation previously described, every effort has been made to ferret out and evade all circumstances tending to make our little sample of facts appreciably misrepresentative of the real general relations or psychologically superficial and misleading. But the next portion of our problem is of a very definite objective nature; we wish to ascertain how far the observed ranks in the several abilities tend to correspond with one another; this, it is believed, is no longer a task to be effected by exertions of psychological ingenuity; instead of constructing complex arbitrary tables and plausible but more or less fanciful explanatory stories, we now are in need of such a procedure as will impartially utilize all our information in the *demonstrably most complete manner* and will focus it to a plain quantitative value; for the moment, psychology has to give way to mathematics.

Accordingly, all the more important correlations in the present work have been worked out by the best method hitherto evolved, that of "product moments," as Pearson terms it; only instead of using the actual measurements obtained for the reagents' respective thresholds, the change has been made of employing the numbers denoting their relative ranks; a full explanation of the advantages of this modification may be found in the article specially devoted to the topic (the chief being a reduction of the probable error equivalent to doubling the quantity of cases observed). Merely subsidiary results have often been reckoned by the much more convenient method of "rank differences," while a few correlations were for various reasons not amenable to either of these more exact methods, and therefore had to be worked out by Pearson's auxiliary method or mine of "class averages" (the latter has generally been preferred, on account of its smaller probable error). All these are but different ways of more or less closely arriving at the same measure of correlation, and thus all the results can be freely compared with one another.

The method of "product moments," though sometimes involving lengthy calculations, is so simple in principle that it can be worked by any moderately intelligent schoolboy. Explanation and illustration are given in the above article; here, nothing more than the general formula can be stated, which is as follows:

$$r = \frac{Sxy}{\sqrt{Sx^2 . Sy^2}}$$

where x = any individual deviation from the general median as regards one of the compared characteristics,

y = the deviation of the same individual as regards the other characteristic,

Sxy = the sum of such products for all the individuals,

Sx^2 = the sum of the squares of all the various values of x,

Sy^2 = the same for y,

and r = the required correlation.

(*b*) *Elimination of Observational Errors.* This necessitates a further mathematical operation, which, however, is very brief and does not involve anything more than elementary arithmetic. There are two formulæ, one theoretical and the other empirical:

1) $$r_{pq} = \frac{r_{p'q'}}{\sqrt{r_{p'_1p'_2} \cdot r_{q'_1q'_2}}}$$

and 2) $$r_{pq} = \frac{\sqrt[4]{mn} \cdot r_{p''q''} - r_{p'q'}}{\sqrt[4]{mn} - 1}$$

where $r_{p'q'}$ = the mean correlation between the various gradings for p and those for q,

$r_{p'_1p'_2}$ = the average correlation between one and another of these several independently obtained series of values for p,

$r_{q'_1q'_2}$ = the same as regards q,

$r_{p''q''}$ = the correlation of an amalgamated series of measurements for p with an amalgamated series for q,

m and n = the number of independent gradings for p and q respectively,

and r_{pq} = the required real correlation between the true objective values of p and q.

It will be found exceedingly important to employ both formulæ simultaneously, for they are independent of one another and each has different sources of fallacy, so that the most essential information is gained by a comparison between their respective results.

When we say that a series of objects correlates entirely with a second series, we do not assert that every set of measurements of the one will absolutely coincide with those of the other, seeing that discrepancies must inevitably arise from errors in measuring; we only mean that whatever all sets of measurements of the one series have in common with each other will also be found common to all measurements of the other series; then, either of the above formulæ will exactly eliminate the observa-

tional discrepancies and thus present the correlation in its entirety.

But much more often the measurements for the same series are connected with one another by *more* than connects them with the measurements of the other series, and then the case is ambiguous. Either the surplus really lies in the series measured, which is equivalent to saying that this series contains elements not common to the other series and that the correlation is to this extent incomplete; here, once more, both formulæ will produce the properly corrected amount. Or, as is usual, the excess of agreement between the measurements for the same series may partly (or wholly) derive from their having the same constant fallacies; and now it will be found that both formulæ give a correction still in the right direction but too small in quantity; further, this deficiency will be much greater for the theoretical formula than for the empirical one, so that *when both formulæ give the same result, we can assume that the latter has not been appreciably falsified by any constant fallacy common to the several sets of measurements for the same series.*

Under special circumstances, the contrary case may occur of the sets of measurements for the one series being connected with each other by *less* than connects them with those of the other series. This will happen whenever several sets of measurements supposed to be taken from the same lot of objects are really procured from different ones and their several correspondences with the second series have arisen from independent causes. In physical matters, this danger is not serious; if two persons decide independently to measure a fossil cave-bear, they are unlikely to make the mistake of going to different animals. But in psychology it is otherwise; persons may honestly endeavor to appraise the same mental faculty, and yet, owing to diversity of procedure and ignorance of organic uniformities, they may really obtain measurements of quite independent function. In such case, the sets of measurement, however accurate they may be, will show no correspondence with one another; and if the functions are even only partially different, the measurements will correspond with one another to that extent less than they would by reason solely of errors of observation.

The effect will be to falsify any corrections by the theoretical formula, for the latter begins by assuming only one lot of objects to have been measured and therefore the correspondence between the sets of measurements to be at least as great as might be expected from their accuracy—an assumption generally fair enough, but under the special conditions delusively reducing the denominator and thus producing a final value proportionally too large. Now, this same fallacy affects cor

rections by the empirical formula in exactly the opposite direction; for the latter bases itself upon the fact that an amalgamation of several sets of measurements constantly emphasizes whatever elements are common to them all and simultaneously obliterates all that are not common; thus in the normal case of only one lot of objects underlying the sets and determining their correlations to the other series, amalgamation will continually raise the correlation towards its full amount; but if there be more than one underlying lot of objects, each correlating with the other series independently, then amalgamation will not emphasize but obliterate these independent influences and consequently not raise but lower the correlation. Hence, when several functions really corresponding with the second series independently have been confounded together and taken for different measurements of a single correspondence, the results, as corrected by the respective formulæ will sharply diverge. Conversely, if, when a double set of measurements has been made the empirical corrective formula produces an increase of correlation, then these sets of measurements may be regarded as certainly deriving from some single common faculty (any influences specific to each set of measurements being theoretically subtracted from the faculty and viewed as merely so many sources of observational error); and *if the two corrective formulæ lead to the same final amount of correlation, then this latter concerns wholly and solely the common faculty.*

Further, it is of great importance to remark that the last fallacy, namely the case when measurements believed to be taken from the same function really derive from different ones correlating with the other series independently, may, by the first corrective formula, easily come to any values greater than 1 (and therefore impossible, seeing that 1 represents entirety). By the empirical formula, on the other hand, this can never occur; for whether the sets of measurements be connected with one another by either anything more or anything less than connects them with the measurements of any other compared series, then the correspondence between the two series will in both cases be reduced and therefore must necessarily be less than 1;[1] in other words, *the empirically corrected correlation can only amount to full unity when all the sets of measurements for both series have one common element and differ in every other systematic constituent.*

Fuller explanation and illustration are given in the article devoted to the topic of measuring correlation.

(*c*) *Elimination of Irrelevant Factors.* This is the final opera-

[1] Except for deviations due to mere chance, whose range will vary with the probable error.

tion necessary to obtain a true result. Unlike the preceding one, it may often be altogether escaped; for if the conditions are favorable and if the preliminary investigation has been sufficiently thorough, the experiment need not be affected by any irrelevant factor of large enough magnitude sensibly to vitiate the result. Here, also, the necessary mathematical work has been reduced to brief and elementary arithmetic; for more explanation, the reader must again be referred to the special article.

If the irrelevant factor be connected with *only one* of the two compared series, the equation is:

$$r_{pq} = \frac{r'_{pq}}{\sqrt{1 - r^2_{pv}}}$$

where r'_{pq} = the apparent correlation of p and q, the two variants to be compared,

r_{pv} = the correlation of one of the above variants with a third and irrelevantly admitted variant v,

and r_{pq} = the required real correlation between p and q, after compensating for the illegitimate influence of v.

If the irrelevant factor be connected with *both* series compared, the equation becomes:

$$r_{pq} = \frac{r'_{pq} - r_{pv} . r_{qv}}{\sqrt{(1 - r^2_{pv})(1 - r^2_{qv})}}$$

where all the terms have the same meaning as before.

CHAPTER V.

THE PRESENT RESULTS.

1. *Method and Meaning of the Demonstration.*

As the reader will have noticed, the formulæ given at the end of the previous chapter are equations whereby from several observed correlations we are able to deduce a single true one. This latter alone is of real scientific significance, and under the ordinary unsystematic conditions — such as governed the great majority of work reviewed in the second chapter — the actually observed correlations will rarely be of much interest in their primitive raw state; for after passing through the proper corrections, they would come forth transfigured in every conceivable manner; some would increase in size, some diminish, some entirely disappear, and some even become inverted. Nevertheless, our true correlation in no way deserves the reproach of being a theoretical abstraction, for it only represents the limit to which the observed correlation itself will continually

approach as improvement is made in the experimental procedure; and not even the most perfect methodics can afford to dispense with the formulæ, seeing that these are the sole means by which the perfection may be adequately ascertained.

Our method of demonstration implies four distinct steps, all of which are believed to be absolutely indispensable for work intending to be more than merely suggestive. First, we must exactly determine the quantity of correlation actually observable, and we must compare it with the probable error; then, if the former be no more than about twice as large as the latter, the whole experiment may indeed have produced a substantial negative result, but cannot possibly warrant any positive conclusion other than to suggest the desirability of extending the investigation until it acquires more evidential value; but if, on the other hand, the observed correlation be four or five times greater than the probable error, we may then consider a *prima facie* case of correspondence to have been established and we may legitimately go on to the corrective processes so as to bring our raw figure to its most probable real amount. Accordingly, the second step will be to form an estimate of the errors in observing the two series compared; for this purpose we must have obtained two or more independent sets of measurements for each series, or at least must be acquainted with the relations found between other such sets under sufficiently similar circumstances; the influence of these errors can then be eliminated by the formulæ given on page 253, and at the same time an opinion can be formed as to the presence or not of the grave fallacies discussed on pages 253 ff. The third proceeding is to look for any factors irrelevantly admitted (or, more rarely, excluded); any suspicions must be carefully verified in succession, and, if necessary, employment must be made of the eliminating equations given on page 256. Finally, we have to critically review the whole argument, paying particular attention to such disturbing factors as have not been disposed of very satisfactorily; in this way we come to a final estimate, not only as to the most probable amount of real correspondence, but also as to the degree of confidence to which our evidence is entitled; for these two things are by no means always parallel, a high apparent correlation often having but small evidential value and *vice versa*.

A few words may now be said concerning the eventual *meaning* attachable to the result which we hope to obtain. To put it briefly, the usual direction of inquiry is in the present work reversed. The customary procedure consists in determining some matter of research subjectively, say, "Perception," "Attention," "Imagination," "Fatigue," etc., and then ascertaining its relation to other similarly pre-determined psy-

choses or neuroses. Here, on the contrary, although every effort has been made to render the mental phenomena as unequivocal and significant as possible, yet in the beginning not the least note is taken of any psychological import beyond such as is barely necessary to define the subject of discussion in the most positive and objective manner; while the structure of language necessitates the continued use of such terms as Discrimination, Faculty, Intelligence, etc., these words must be understood as implying nothing more than a bare unequivocal indication of the factual conditions of experiment. For the moment we are only inquiring how closely the values gained in the several different series coincide with one another, and all our corrections are intended to introduce greater accuracy, not fuller connotation; the subjective problems are wholly reserved for later investigation. It is no new thing thus elaborately to deal with and precisely measure things whose real nature is concealed from view; of this nature, for instance, is obviously the study of electricity, of biology, and indeed of all physical science whatever.

Let us, then, consider the extent of connection between two series of things implied by this sole fact of their presenting a numerical correlation with one another; such a correspondence, when beyond the range of mere chance coincidence, may be forthwith assumed to indicate and measure *something common to* both series in question. Such a community may often consist of a definite so-called "substance;" A's changes of wealth will show some correlation with those of B, if both possess some shares in the same stock. Or, on the other hand, the community may derive from a more complicated interaction of forces; thus, the weather is supposed to correlate with the state of the spots on the sun. But this distinction is superficial even in physical matters; thingness may well be an indispensable crutch for popular thought, and indeed in metaphysics becomes a serious enough topic, but it has no place in strict natural science and still less in psychology, where fast limit has never been securely traceable between things, qualities, and conditions.

But the same simple mathematical formulæ which have brought us so far will take us yet farther. As from several sets of inaccurate measurements it has been found possible to arrive at the accurate correlation of the two real series, so now in a similar manner from any number of real series we can proceed on to dealing exclusively and precisely with any element that may be found common to these series; from ascertaining the inter-correlations of, say, auditory discrimination, visual discrimination, the capacity for learning Greek, and that for playing the piano, we can arrive at estimating the

correspondence of whatever may be common to the first pair of faculties with whatever may be common to the second pair. By combining such correlations of higher order, it is feasible to execute any required amount of elimination and selection, so that eventually a dissociation and exactness may be introduced into psychology such as can only be compared with quantitative chemical analysis; even in the present work, it is hoped to obtain results of sufficient fineness to be independent of local conditions of experiment, and therefore to be precisely verifiable by any other workers. All the time, the relations discovered by us will wholly retain their impartial objective character; however accurately we may learn the distribution of community, it will remain as a later and very different task to detect and analyze its psychical nature. But we shall find that the successive positive ascertainment of objective relations continually reduces and simplifies the thinkable explanatory hypotheses, so that practically our method of investigation is bringing us towards the introspective psychological solution also—and perhaps in the end by the shortest route.

2. *Correspondence between the Discriminations and the Intelligences.*

(*a*) *Experimental Series I.* We will begin by dealing with the subject broadly and considering the general average correlation between the various forms of Discrimination and those of Intelligence. To establish our *prima facie* case, we note that Discrimination has been tested in three senses and that Intelligence has been graded by three different persons; thus we have nine correlations which, if no correspondence exist, should all be small (about half of them under 0.09) and approximately as many should be inverse as direct. Far from this being the case, we find that every single one is direct, that the smallest amounts to 0.25, and that the average comes to 0.38 with a probable error of about only 0.02. Now, a correlation thus more than nineteen times the size of its probable error would not occur by mere accident in millions of trials, so that chance, as a possible cause of the apparent correlations, may at once be put completely out of court. Our result has thus made good its right to further elaboration.

But when we consequently proceed to discount the errors ot measurement, it unfortunately becomes clear that our data are far from being adequate for the purpose; we have, indeed, a duplicate set of observations for Common Sense, but none for School Cleverness nor for any of the Sensory Discriminations. The excuse for the deficiency lies to some degree in practical difficulties, but still more in the fact that at the time of the experiments I was only just beginning to realize the necessity of

such duplication. In default, then, of better information, the other errors will provisionally be taken as being about the same size as those for Common Sense (later on we shall have opportunity of partially checking this assumption); on this basis, an elimination of the observational errors by our first or theoretical formula brings the required correlation to 0.60.[1] This result can now be compared with that given by the second formula; for this purpose we utilize the fact that Common Sense and School Cleverness prove to be not very different criteria, so that all three lists may be used as measurements of practically the same intellectual faculty; if we accordingly amalgamate these three lists into one, the latter shows an average correlation with the Discriminations amounting to 0.44 and our required correlation comes to 0.54,[2] or somewhat smaller than by the other way. Such a decrease by the empirical as compared with the theoretical formula could be produced by two causes: either the estimation of School Cleverness might have been more accurate than those for Common Sense, or else there could have occurred the fallacy a priori feared by us, namely that the three critics had been warped by the same prejudices and therefore not able to judge with sufficient independence of one another. As, however, the total divergence only amounts to 0.06, we can conclude that neither of the above disturbances can have existed to any appreciable degree, and we might well ascribe even the small apparent difference to mere chance variation; but to be on the safe side we will adopt the lower value, 0.54.

We next pass to the inquiry into irrelevant factors and will commence with the conspicuous one of Sex. This to all appearance manifests a connection with both Discrimination and Intelligence, and therefore might conceivably be the sole cause of the two latter being congruous with one another. But closer inspection alters the aspect of affairs; for while Sex and Discrimination only show a correlation with one another to the

---

[1]
$$\frac{0.38}{\sqrt{0.64 \times 0.6}} = 0.60$$

[2] The two forms of intelligence coincide to the extent of 0.84, so that the equation becomes approximately
$$\frac{\sqrt{2+0.84^2} \times 0.44 - 0.38}{\sqrt{2+0.84^2} - 1} = 0.54.$$

Even if we neglect the slight discrepancy between the two sorts of intelligence, the result will not be very different, for

$\dfrac{\sqrt{3} \times 0.44 - 0.38}{\sqrt{3} - 1} = 0.53.$ Note that as we have here an amalgamation for only *one* of the two compared series, we must take the square instead of the fourth root of the number of amalgamated lists.

extent of 0.26 (after correction for errors), they respectively correlate with Intelligence to the amounts of 0.59 and 0.54; so that the true correlation between Sex and Discrimination comes to −0.07,[1] that is to say it entirely disappears. Thus it would seem that the correspondences of Discrimination and Intelligence with Sex are in no degree the causes but merely effects of their correspondence with one another and that *the fluctuating differences of Sensory Discrimination observable in connection with Sex at the various stages of growth are chiefly and perhaps altogether a mere consequence of similarly fluctuating differences in their Intelligence.* This hypothesis tallies well with other indications; in the experiments of Gilbert, for instance, as to the most characteristic discrepancies between boys and girls at the various ages, the two senses tested (visual and muscular) present an almost identical progress, as if both were depending on some common influence. The same conclusion can be more directly derived from the fact that either the boys or the girls, taken separately, present correlational values very similar to the above; but such a subdivision so reduces the number of conjoined cases that the probable error becomes too formidable for the attainment of sufficiently regular results. Hence it has been thought both permissible and advantageous to throw the boys and girls together into the one collective experiment.

The next obvious irrelevant factor is that of Age, which apparently exhibits correlations with Discrimination and Intelligence of 0.37 and 0.42 respectively. But as regards the former, first, the true value obtained in the same way as before descends down to only 0.18,[2] thereby not indeed this time disappearing but still coming almost within reach of some bias in the operation of grading; possibly, then, the connection of Age with Discrimination is at least in the main, like that of Sex, no more than an effect of their common correspondence with Intelligence; this would accord with the strange phenomenon noted above, that Intelligence appears temporarily to diminish about the eleventh year, for precisely the same occurs to their powers of Sensory Discrimination (a fact first pointed out by Gilbert and noticeable in the present experiments also). To turn to the other above indicated correspondence, that between Age and Intelligence, all those who furnished me with their personal estimation of the children's comparative intellect had been particularly requested to do so entirely regardless of Age, and they had anticipated no difficulty on this head declaring

1 $$\frac{0.26 - 0.59 \times 0.54}{\sqrt{(1 - 0.59^2)(1 - 0.54^2)}} = -0.07$$

2 $$\frac{0.37 - 0.42 \times 0.54}{\sqrt{(1 - 0.42^2)(1 - 0.54^2)}} = 0.18$$

that their opinions were naturally formed quite independently of any such consideration. But we have seen good reason for being very strict in this respect, and when we actually examine the figures, the observed deviations are often far greater than can be attributed to mere chance; from seven to ten years it is the little ones who are favored and to the large extent of 0.65, which is, however, in this case only three times the abnormally big probable error;[1] but from ten to fourteen the above correlation of 0.42 is found in the opposite direction and upon being corrected only descends to 0.38,[2] which is more than seven times its probable error and therefore would not occur by mere coincidence in many thousand times. Thus we are impelled to believe, either that judgment of Intelligence is to a great though unconscious extent biased by consideration of Age, or else that there is a stage of development somewhere near the eleventh year where Intelligence temporarily declines; in connection herewith we have the curious fact that from about eleven to twelve years there appears to ensue a suspension in the growth of children's heads. Returning finally to our main topics with these two values, 0.18 and 0.38, the corrected correlation between Discrimination and Intelligence now comes to the slightly reduced amount of 0.52.[3]

Passing to the next irrelevant factor, Practice, this influence has in the third chapter shown itself to be only moderate as regards distinguishing Light, and still smaller as concerns Weight; moreover, there is no reason to suppose that the children differed appreciably from one another in their amount of previous practice with these two kinds of activity. But in the matter of Sound all this is reversed, for even the most homogeneous school presents a wide diversity of musical education, and we have already seen that such circumstance is of enormous influence. Taking the quantitative estimates given on page 231, in conjunction with the average and its mean deviation in Table I, the correspondence of Discrimination and Practice can be reckoned out to probably amount in such a school to something like 0.70. This very large factor must therefore be eliminated be-

[1] This result depends upon only one short set of observations; also no detailed rank had been furnished, but merely that favorite but particularly bad classification into "bright," "average," and "dull."

[2]
$$\frac{0.42 - 0.54 \times 0.18}{\sqrt{(1 - 0.54^2)(1 - 0.18^2)}} = 0.38$$

This method of correcting three inter-correlated terms in succession beginning with the smallest of them, though far from being theoretically exact, nevertheless appears sufficiently applicable to the large majority of actual cases including the present one.

[3]
$$\frac{0.54 - 0.38 \times 0.18}{\sqrt{(1 - 38^2)(1 - 0.18^2)}} = 0.52$$

fore we can hope to obtain an approximately true result. As it only affects Auditory Discrimination, the total average will thereby be finally increased to about 0.58.

So far, we have broadly taken the general average correlation between all the kinds of Discrimination and those of Intelligence. Let us next briefly consider the individual relations between the several specific sensory and intellective faculties. Common Sense and School Cleverness present practically the same amounts, their raw correlations being 0.39 and 0.36 respectively, so that there appears no object in treating these separately. The various sensory departments show apparently much larger discrepancies: for Weight, which has a raw correlation of 0.34, after correction we eventually get 0.43; for Light, with a raw correlation of 0.44, we come to 0.58; and for Sound, with a raw correlation of 0.37, we arrive at no less than 0.71. To this disparity, however, no great evidential value can be attached, until more positive estimates have been obtained as to the errors of measurement; the above rank might really only mean that the accuracy of experimentation had been least in the thresholds for Weight and greatest in those for Pitch.

Lastly comes the process of reviewing the whole argument. Clearly enough, it has in many respects been of a rough character. The arbitrarily assumed observational errors for School Cleverness and for Discrimination were but inadequately checked in the former case and not at all in the latter; while the irrelevant influence of previous practice on Auditory Discrimination was based upon solid but too general data. Also, there is always the danger that other unsuspected irrelevant factors may exist in harmful magnitude; on this head, however, the precautions taken appear fairly adequate; chapter III only shows the results of the preliminary investigation as regards those factors which finally proved most formidable, but a great number of others have been thoroughly examined and their influence has been found to be inappreciable for our present purpose. Among all these sources of inaccuracy, it will be manifest how insignificant is here the rôle of the probable error of the raw main correlation (0.02); thus, though the reagents were only twenty-four in all, it would have been worse than useless to augment their number at the expense of correctness in other respects; for the present, increased precision must be chiefly sought by other means. To sum up, the most likely value for the average correlation between the Discriminations and the Intelligences comes to about 0.58, but this final conclusion must be considered as having a large total probable error, say, 0.10.

(*b*) *Experimental Series II.* On first inspection, the results here would seem diametrically opposed to our last ones, the

correlation turning out to be on the *minus* side, so that Discrimination would appear correlated to the extent of 0.39[1] not with Intelligence but with Stupidity.

But we again notice that both Intelligence and Discrimination are irrelevantly correlated with Age, and to the large amounts of 0.69 and 0.81 respectively.[2] On applying the corrective formula, the true correlation turns round to +0.41,[3] whereby the paradox is readily resolved into a result under the circumstances perfectly normal; we should expect the amount to be smaller than in the former experimental series, because the observational errors must have been greater and have required larger compensation than before, whereas we have given the same.

Thus it is once more evident that the influence of irrelevant factors, though sometimes of moderate magnitude (as in the preceding series) may at other times assume such dimensions as to wholly reverse the conclusion. Nor would such an effect be in the least diminished by increasing the number of reagents experimented upon.

Except for this lesson concerning the danger of irrelevant factors, there is little information to be gleaned from the present series; for while the observed correlation is only —0.25, the probable error comes to no less than 0.18; in other words, such a correlation would turn up about every third time, either when no correspondence existed at all, or when there really was one twice as large. Hence we see that though a short series of cases *may* be managed in such a way that the rôle of the probable error becomes insignificant, yet this is not necessarily so; when the data are gained in the customary unscientific manner, the results of these brief experiments are worthless for persons versed in correlational methodics and delusive for those who are not so.

(*c*) *Experimental Series III.* Here the probable error has been reduced to more reasonable dimensions (0.06 for the average of two correlations); also the disturbances from Sex and Age have been eliminated. But on the other hand (as we have seen on page 248), the sensory tests were so unsatisfactory that the attenuation by errors must be estimated of enormous magnitude. Quite accordingly, the observed correlations of Intelligence with Visual and Tactual Discrimination are no more than 0.13 and 0.12 respectively. Upon this diminutive basis we cannot attempt to pile the very large and vague corrections that would be necessary.

Thus we see that an inadequate way of testing the reagents,

---

[1] The raw correlation is −0.25.

[2] The raw correlations are 0.55 and — 0.65 respectively.

[3] $$\frac{-0.39 - 0.69 \times (-0.81)}{\sqrt{(1-0.69^2)(1-0.81^2)}} = +0.41.$$

whether due to circumstances, want of skill, or undue hurry, will so increase the attenuation by errors that the raw observable correlation is brought down to a vanishing minuteness. This effect, so far from being remedied by increasing the range of the experiments and the number of cases, will almost inevitably be augmented thereby.

The principal information to be gleaned from this series is that the correspondence between Discrimination and Intelligence cannot well be appreciably due to Zeal, for the latter faculty had upon this occasion become the paramount differentiating influence.

(*d*) *Experimental Series IV.* On this occasion circumstances were as favorable to accuracy of experimentation (see page 249) as in the last two cases they had been the reverse. Accordingly, we find that Discrimination correlates with Talent in the four branches of study, Classics, French, English, and Mathematics, by an average of 0.51 with a probable error of only 0.03. This proportion of over 17 to 1 is amply sufficient to warrant us in proceeding to determine the real correspondence with considerable precision.

We will again take first the errors of measurement. As regards Intelligence, there was no difficulty in obtaining the required data; for the gradings were based upon the regular school examinations, so that if several of these be taken simultaneously into consideration, each will constitute a sufficiently independent set of measurements. The errors prove much smaller than those in the first experimental series; one examination paper correlates with another in the same branch of study by an average of 0.86; and one total examination correlates with another total examination by an average of 0.95; so that whereas before we had to make a compensation of 24%, we now only require those of 7% and 2%. From this it would appear that examination papers form a test that is far more constant and free from accidental errors of judgment than are teachers' subjective impression as to the "brightness" of their wards; but still this only refers to the reliability of the testing process and does not prejudice the question to be subsequently discussed as to whether the kinds of intelligence tested are different and of unequal value. As concerns the grading of Discrimination, unfortunately the same impediment again frustrated the attainment of several independent sets of observations, so that we once more have no precise measure of compensation; we shall therefore have to make the same free estimate as before. Correcting, then, for both Intelligence and Discrimination, we get a true value of 0.69.[1]

---

[1] $$\frac{0.51}{\sqrt{0.86 \times 0.64}} = 0.69$$

Proceeding next to irrelevant factors, these appear to have been reduced in the present series to such a minimum that there is no more any necessity for theoretical corrections. The matter of Sex does not again come into the question, since this school is only of boys. Nor is Age this time a disturbant, for its correlation with Discrimination works out to the insensible amount of -0.07. The latter circumstance completely disposes of another possible objection, for it might be urged against Experimental Series I that Age is by no means identical with stage of Growth, some children being more precocious than others, so that our correction to eliminate the former factor does not necessarily suffice to nullify variety in the latter one; hence, it might be argued, the whole correspondence between Intelligence and Discrimination could conceivably be due merely to the brighter children being also more forward with their senses. But though it must certainly be admitted that Age and Growth do not always keep level with one another, yet they at any rate correspond to the extent that when the former has ceased to exercise any influence at all the latter also must have become entirely inoperative; and as throughout the school the older boys do not in the least surpass the younger ones in Discrimination of Pitch, we may safely say that their faculty in this respect no longer depends to the smallest degree either on their Age or even on the stage of their Growth.

Still it may be interesting to know what would have occurred had the school lists not been artificially modified, but allowed to retain the factor of Age. In such case, the correlation comes to only 0.45.[1] Thus by eliminating Age we had increased the correlation from 0.45 to 0.69; but to obtain such a rise it can easily be calculated that we must remove an irrelevant factor amounting to about 0.76;[2] now, in the unmodified lists the actual correspondence of Age with Class Order turns out to be precisely this amount. Thus it would appear that *the influence of Age was wholly irrelevant;* not actual Proficiency but Native Capacity is the factor directly correlated with Discrimination; our apparently somewhat theoretical modification of the original school order was no empty abstraction but had after all a solid enough basis in present fact; if with regard to the educational curriculum it merely represented future possibilities, yet in other directions it showed itself to correspond with already efficient powers.

It is now also evident that the whole process of modifying

---

1 $$\frac{0.33}{\sqrt{0.86 \times 0.64}} = 0.45$$

2 $$0.69 = \frac{0.45}{\sqrt{1 - x^2}}, \text{ so that } x = 0.76.$$

the school lists could have been avoided; we could have left them in their raw state and simply have eliminated the irrelevant factor of Age by our usual formula; in this way, indeed, the theoretical precision would have been far greater, for our artificial treatment of the lists is only even approximately correct when Age is a paramount influence in deciding school place, and if applied, say, to university students, would produce an improper decrease (never increase) in the observed correlations; but practically the advantage is generally the other way, as in the present case, for the above theoretical incorrectness is more than compensated by a reduction gained in the probable error, owing to our being able to actually observe more of the correlation and thus leaving less to obtain by calculation.

As regards possible irrelevant correspondence with Practice, the present experimental series is again favorably situated; for though this factor has its usual large influence upon Discrimination of Pitch, there are in this case some positive data wherewith to measure it. Out of the thirty-three children it was ascertained that twenty-two were taking lessons in music, and these not unnaturally showed a much finer Sensitivity (a median of 2.3 v. d. as against one of 5 v. d.). We can therefore reject the eleven not learning music, thus confining the experiment to reagents on nearly the same level as concerns Practice; upon doing so, the correlation makes a further rise to 0.78.[1] Or else we can work out the correlation of Discrimination with Music Lessons, and then remove this irrelevant factor by means of our formula; thereby we arrive at a similar value.

Let us now sum up this fourth series. With respect to the correlations of Discrimination with the School Studies *separately* we have arrived at an average of 0.78, of which figure 0.57 has been actually observed; to this aggregate 0.89 is contributed by Classics, 0.88 by French, 0.73 by English, and 0.61 by Mathematics; here the order may be considered as well enough evidenced, the ambiguity present in the first series having disappeared, since the observational errors have been calculated separately for each study. The correlation of Discrimination with the *Total* School Ability can be calculated with equal ease; the average raw correlation is 0.68, while the successive Total School Orders correlate with one another by 0.95, so that the corrected required correlation becomes 0.87.[2]

In this series we have had the good fortune, not only to ob-

---

[1] $$\frac{0.57}{\sqrt{0.86 \times 0.64}} = 0.78$$

[2] $$\frac{0.68}{\sqrt{0.64 \times 0.95}} = 0.87$$

tain reliable estimates of almost all the perturbing influences, but even to eliminate them in practice so that an average of no less than 0.68 can be actually observed. In the further calculation the only value that cannot be approximately relied upon is that of the errors in measuring Discrimination, and even this cannot well be very much smaller than the amount here adopted and, as is subsequently proved, cannot possibly be much larger. The existence of other sources of fallacy yet lurking, either to reduce or to still further augment the total cannot of course ever be categorically disproved; but at any rate a careful search has been made and has so far failed to reveal them. The whole system of results exhibits such regular unconstrained compliance with the definite laws governing correlations (and also present such other remarkable uniformities to be discussed later on) that they appear to offer every guarantee of being perfectly normal.

The correlational value is, however, considerably larger than that found for the same sense in Experimental Series I. The readiest explanation of this discrepancy would appear to lie in a fact which I have often had occasion to notice, namely that when the reagents are very unpractised in any form of sensory Discrimination. the latter correlates with their Intelligence by a much smaller amount.

(*e*) *Conclusions.* On the whole, then, the results of all four experimental series appear sufficiently concordant with one another. Whenever we have succeeded in obtaining a fairly pure correlation between Sensory Discrimination and Life Intelligence, we have found it amount to a very considerable value. In the case of Pitch, it came to as high as 0.87. Very possibly other discriminative functions would show similar results, while some would prove much more specific (and usually dependent on factors peripheral to the nervous system).

3. *Correspondence between General Discrimination and General Intelligence.*

Up to now, we have only discussed the correspondence of the various Intelligences with the various sensory activities, Hearing, Sight, Touch, etc. Such isolated facts are interesting enough, but quite otherwise important is the relation of *any common and essential element in the Intelligences to any common and essential element in the Sensory Functions.* For brevity, we will term these common elements "General Intelligence" and "General Discrimination," but always with the reservations made in the first section of this chapter.

Curiously, this more general correspondence can in the present case be settled with much greater precision than was possible for the specific relations. This is due to our now

having adequate data wherewith to measure the errors of observation, seeing that all the experimentally obtained gradings of specific Discrimination constitute so many one-sided independent attempts to grade the General Discrimination; the amount of observational error will be quantitatively revealed in the correlations between one grading and another.

(*a*) *The Village School.* Here our calculation is as follows. The average of the nine correlations between the Intelligences and the Discriminations comes, as we have seen, to 0.38;[1] the two kinds of intellective gradings correlate with one another by an average of 0.55; and the three gradings in Discrimination do so by 0.25.[2] Therefore by the theoretical formula the true correlation between General Intelligence and General Discrimination comes to

$$\frac{0.38}{\sqrt{0.55 \times 0.25}} = 1.01.$$

Checking this by the second or empirical method, we find that on taking an amalgamation of the three intellective gradings with an amalgamation of the three gradings in Discrimination, the correlation rises to 0.66. Therefore the true correlation between General Intelligence and General Discrimination comes in this way to

$$\frac{\sqrt{3} \times 0.66 - 0.38}{\sqrt{3} - 1} = 1.04$$

This again may be further checked by taking our amalgamation two instead of three lists at a time; in this way we get nine different correlations which present an average of 0.55, so that our required result now becomes 0.96.[3] Therefore an average again gives us as nearly as possible 1.00.

Thus we arrive at the remarkable result that the *common and essential element in the Intelligences wholly coincides with the common and essential element in the Sensory Functions.*

(*b*) *The High Class School.* Here, also, the children were tested in the three senses, but unfortunately, as we have seen, the results for Light and Weight are not seriously usable,[4] so that we no longer have sufficient material for constructing a "General" Discrimination.

[1] These correlations are here taken as actual measurements, and therefore are obviously required raw, not corrected; the correction then issues from their joint product according to the formula.

[2] This value is precisely the same as that found for adults: see Table V.

[3]
$$\frac{\sqrt{2} \times 0.55 - 0.38}{\sqrt{2} - 1} = 0.96$$

[4] As far as they go, they indicate results entirely similar to those above.

This default, however, has been made good by what appears to be a very happy substitute. Our main correlations have dealt with reagents all undergoing musical instruction, and I have kindly been furnished with a complete order of their relative abilities in this department. Musical talent has always been recognized as being not so much an intellective as a sensory function; whole nations appear almost devoid of it, without therefore showing themselves any less intelligent; lunatic asylums, on the contrary, often contain a surprising share of the faculty. We will, then, take this as our second sensory function, will note whether it presents any community with Discrimination of Pitch, and if so will compare this common element with that obtaining between the intellective functions. As regards the first point, it may be noted that hitherto very conflicting opinions have been stoutly maintained; the great majority of writers have held Musical Talent and Pitch Discrimination to be very intimately connected and even go so far as to directly term the discriminative power "musical sensitiveness;" while a few, but including perhaps the ablest judges, flatly deny any such correspondence whatever. The actual facts would at first sight seem to lie wholly on the side of the former tenet, seeing that the correlation works out to the substantial amount of 0.40 (or about 0.63, when corrected for errors). Next, these two auditory functions correlate with the Intelligences by 0.57 and 0.55 respectively, and the latter correlate with one another to the amount of 0.71. Thus the relation between the element common to the two former and that common to the four latter will be given by

$$\frac{0.56}{\sqrt{0.40 \times 0.71}} = 1.04$$

We can now check the result by the empirical formula; for we find that the amalgamated order derived from the two sensory faculties correlates with the amalgamated order derived from the four Intelligences by 0.72; so that the required correlation comes to

$$\frac{\sqrt[4]{8} \times 0.72 - 0.56}{\sqrt[4]{8} - 1} = 0.96$$

Taking as usual the mean,[1] we again reach a final correlation of precisely 1.00, and therefore once more must conclude that the element common to the sensory activities also wholly coincides with that common to the intelligences.

[1] If this small difference of value between the theoretical and empirical results be minutely investigated, it can be clearly proved to be solely attributable to mere chance, as indeed might well be expected from its small dimensions.

Before passing, it may be remarked that thus after all those were virtually in the right who maintained Musicality and Pitch Discrimination to have no correspondence with one another; for though a correspondence really does exist, yet it is not to the smallest degree of the specific character contemplated by those who talk of "musical sensitivity." It must here also be noted that this surprising intellectuality of musical talent by no means annihilates the many well-evidenced phenomena seeming to indicate the contrary; one fact cannot destroy another, and any apparent conflict merely proves our imperfect acquaintance with their true nature.

(*c*) *Practical Verification of the Argument.* The conclusion above arrived at is so important and the method of argument is so new, that I have endeavored to reproduce analogous circumstances artificially, so that any one may easily test any portion of the reasoning.

The main argument was repeated as follows. A target was constructed of a great many horizontal bands, numbered from top to bottom. Then a man shot successively at a particular series of numbers in a particular order; clearly, the better the shot, the less numerical difference between any number hit and that aimed at; now, just as the measurement of any object is quite appropriately termed a "shot" at its real value, so, conversely, we may perfectly well consider the series of numbers actually hit in the light of a series of measurements of the numbers aimed at. When the same man again fired at the same series, he thereby obtained a new and independent[1] series of measurements of the same set of objects. Next, a woman had the same number of shots at some set numbers in a similar manner. If, then, our above reasoning and formulæ are correct, it should be possible, by observing the numbers hit and working out their correlations, to ascertain the exact resemblance between the series aimed at by the man and woman respectively. In actual fact, the sets of numbers hit by the man turned out to correlate with those hit by the woman to the extent of 0.52; but it was noted that the man's sets correlated with one another to 0.74, and the woman's sets with one another to 0.36; hence the true correspondence between the set aimed at by the man and that aimed at by the woman was not the raw 0.52, but

$$\frac{0.52}{\sqrt{0.74 \times 0.36}} = 1.00,$$

that is to say, the two persons had fired at exactly the same series of bands, which was really the case. I repeated this ex-

[1] Provided, of course, that there be no appreciable constant error.

periment, testing three times by the first or theoretical formula and four times by the empirical one; by both methods the average came to just upon 1.00, with a mean variation above and below of precisely similar dimensions to those in our instances of Discrimination and Intelligence. Thus the experimental justification of our method of argumentation was as complete as could well be desired.

(*d*) *Conclusion.* On the whole, then, we reach the profoundly important conclusion that *there really exists a something that we may provisionally term "General Sensory Discrimination" and similarly a "General Intelligence," and further that the functional correspondence between these two is not appreciably less than absolute.*

Besides its intrinsic value, such a general theorem has the enormous advantage over the specific results of the last section of being independent of any particular conditions; it has nothing to do with the procedure selected for testing Discrimination and Intelligence, nor even with the accuracy of its execution, nor indeed even with the homogeneousness of the experimental subjects; if correct, the proof should be reproducible in all times, places, and manners — on the sole condition of adequate methodics.

4. *Universal Unity of the Intellective Function.*

In view of this community being discovered between such diverse functions as in-school Cleverness, out-of-school Common Sense, Sensory Discrimination, and Musical Talent, we need scarcely be astonished to continually come upon it no less paramount in other forms of intellectual activity. Always in the present experiments, approximately, $\dfrac{r_{pq}}{\sqrt{r_{pp} \cdot r_{qq}}} = 1.$[1]

I have actually tested this relation in twelve pairs of such groups taken at random, and have found the average value to be precisely 1.00 for the first two decimal places with a mean deviation of only 0.05. All examination, therefore, in the different sensory, school, or other specific intellectual faculties, may be regarded as so many independently obtained estimates of the one great common Intellective Function.

Though the range of this central Function appears so universal, and that of the specific functions so vanishingly minute, the latter must not be supposed to be altogether non-existent.

---

[1] Where r_{pq} = the mean of the correlations between the members of the one group p with the members of the other group q,
r_{pp} = the mean of the inter-correlations of the members of the group p among themselves,
and r_{qq} = the same as regards group q.

We can always come upon them eventually, if we sufficiently narrow our field of view and consider branches of activity closely enough resembling one another. When, for instance, in this same preparatory school we take on the one side Latin translation with Latin grammar and on the other side French prose with French dictation, then our formula gives us a new result; for the two Latin studies correlate with the French ones by an average of 0.59, while the former correlate together by 0.66 and the latter by 0.71; so that the element common to the Latin correlates with the element common to the French by

$$\frac{0.59}{\sqrt{0.66 \times 0.71}} = 0.86 \text{ only.}$$

That is to say, the two common elements by no means coincide completely this time, but only to the extent of 0.86^2 or 74%;[1] so that in the remaining 26%, each pair must possess a community purely specific and unshared by the other pair.[2]

We therefore bring our general theorem to the following form. *Whenever branches of intellectual activity are ~~at all~~ dissimilar, then their correlations with one another appear wholly due to their being all variously saturated with some common fundamental Function (or group of Functions).* This law of the Universal Unity of the Intellective Function is both theoretically and practically so momentous, that it must acquire a much vaster corroborative basis before we can accept it even as a general principle and apart from its inevitable eventual corrections and limitations. Discussion of the *subjective* nature of this great central Function has been excluded from the scope of the present work. But clearly, if it be mental at all, it must inevitably become one of the foundation pillars of any psychological system claiming to accord with actual fact — and the majority of prevalent theories may have a difficulty in reckoning with it.

Sufficient
(Corrected
Br. J. Psy.
III: 3

Of its objective relations, the principal is its unique universality, seeing that it reappears always the same in all the divers forms of intellectual activity tested; whereas the specific factor seems in every instance new and wholly different from that in all the others. As regards amount, next, there seems to be an immense diversity; already in the present examples, the central factor varies from less than 1/5 to over fifteen times the size of the accompanying specific one. But all cases appear equally susceptible of positive and accurate measurement; thus we are becoming able to give a precise arithmetical limitation

[1] The influence of an element is measured by the *square* of its correlational value. See "The Association between Two Things."

[2] Of course this specific community is further resolvable into natural talent and favoring circumstances of which factors the latter may often be paramount.

to the famous assertion that "at bottom, the Great Man is ever the same kind of thing."

Finally, there is the exceedingly significant fact that this central Function, whatever it may be, is hardly anywhere more prominent than in the simple act of discriminating two nearly identical tones; here we find a correlation exceeding 0.90,[1] indicating the central Function to be more than four times larger than all the other influences upon individual differentiation. Not only the psychical content but also the external relations of Sensory Discrimination offer a most valuable simplicity; for it is a single monotonous act, almost independent of age, previous general education, memory, industry, and many other factors that inextricably complicate the other functions. Moreover, the specific element can to a great extent be readily eliminated by varying and combining the kind of test. For these reasons, Discrimination has unrivalled advantages for investigating and diagnosing the central Function.

5. *The Hierarchy of the Intelligences.*

The Theorem of Intellective Unity leads us to consider a corollary proceeding from it logically, testing it critically, and at once indicating some of its important practical uses. This corollary may be termed that of the Hierarchy of the Specific Intelligences.

For if we consider the correspondences between the four branches of school study, a very remarkable uniformity may be observed. English and French, for instance, agree with one another in having a higher correlation with Classics than with Mathematics. Quite similarly, French and Mathematics agree in both having a higher correlation with Classics than with English. And the same will be found to be the case when any other pair is compared with the remainder. The whole thus forms a *perfectly constant Hierarchy* in the following order: Classics, French, English, and Mathematics. This unbroken regularity becomes especially astonishing when we regard the minuteness of the variations involved, for the four branches have average correlations of 0.77, 0.72, 0.70, and 0.67 respectively.

When in the same experimental series we turn to the Discrimination of Pitch, we find its correlations to be of slightly less magnitude (raw) but in precisely the same relative rank, being: 0.66 with Classics, 0.65 with French, 0.54 with English, and 0.45 with Mathematics. Even in the crude correlations furnished by the whole school without excluding the non-musicians, exactly the same order is repeated, though with

[1] See page 276.

the general diminution caused by the impurity: Classics 0.60, French 0.56, English 0.45, and Mathematics 0.39.

Just the same principle governs even Musical Talent, a faculty that is usually set up on a pedestal entirely apart. For it is not only correlated with all the other functions, but once again in precisely the same order: with Classics 0.63, with French 0.57, with English 0.51, with Mathematics 0.51, and with Discrimination 0.40. Ability for music corresponds substantially with Discrimination of tones, but nevertheless not so much as it does with algebra, irregular verbs, etc.[1]

The actual degree of uniformity in this Hierarchy can be most conveniently and summarily judged from the following table of correlation; the values given are those actually observed (theoretical correction would modify the relative order, but in no degree affect the amount of Hierarchy or otherwise). Each number shows the correlation between the faculty vertically above and that horizontally to the left; except in the oblique line italicized, the value always becomes smaller as the eye travels either to the right or downwards.

	Classics.	French	English.	Mathem.	Discrim.	Music.
Classics,	*0.87*	0.83	0.78	0.70	0.66	0.63
French,	0.83	*0.84*	0.67	0.67	0.65	0.57
English,	0.78	0.67	*0.89*	0.64	0.54	0.51
Mathem.,	0.70	0.67	0.64	*0.88*	0.45	0.51
Discrim.,	0.66	0.65	0.54	0.45		0.40
Music,	0.63	0.57	0.51	0.51	0.40	

Altogether, we have a uniformity that is very nearly perfect and far surpasses the conceivable limits of chance coincidence. When we consider that the probable error varies between about 0.01 for the ordinary studies to about 0.03 for music, it is only surprising that the deviations are not greater. The general Hierarchy becomes even more striking when compared with

[1] Of course, notable instances will easily be found where musical ability is apparently divorced from General Intelligence; in this very school, for example, the best musician is far from standing high intellectually. But not even the most extreme cases necessarily contravene the above rule. A correlation does not state any absolute coincidence between two faculties, but only a limited and precisely measured tendency in this direction; so far from excluding deviations, it proclaims them and even estimates their exact probability. If we may assume the normal law of frequency to approximately hold good and may abstract from further influences, then the proportion of persons with any given amount of musical talent who will attain to any given degree of stupidity (or *vice versa*)

$$= \frac{1}{2} - \frac{1}{\sqrt{\pi}} \int^{ah} e^{-t^2} dt$$

where h is a measure of the correlation between Musicality and Intelligence, and a = the given inferiority in the latter faculty.

the oblique line, which is no measure of the central Function and where consequently the gradation abruptly and entirely vanishes.[1]

The above correlations are raw, and therefore do not tell us either the true rank of the respective activities or the full absolute saturation of each with General Intelligence. For the former purpose we must eliminate the observational errors, and for the latter our result must further be *squared*.[2] Thus we get:

Activity.	Correlation with Gen. Intell.	Ratio of the common factor to the specific factor.	
Classics,	0.99	99 to	1
Common Sense,	0.98	96	4
Pitch Dis.,	0.94	89	11
French,	0.92	84	16
Cleverness,[3]	0.90	81	19
English,	0.90	81	19
Mathematics,[4]	0.86	74	26
Pitch Dis. among the uncultured,[5]	0.72	52	48
Music,	0.70	49	51
Light Dis.,[5]	0.57	32	68
Weight Dis.,[5]	0.44	19	81

It is clear how much the amount of any observable raw correlation depends upon the two very different influences: first, there is the above intellective saturation, or extent to which the considered faculty is functionally identical with General Intelligence; and secondly, there is the accuracy with which we have estimated the faculty. As regards the ordinary school

[1] The only other data of this kind with which I am acquainted are some comparisons made between the different branches of study at the Columbia University in the course of the research quoted on page 218. The correlations there obtained, which were throughout somewhat smaller than the above, manifest only a limited concordance with our above principle of Hierarchy. But a university is clearly not the place in which to look for natural correspondence between functions; at that time of life, strong ties of a wholly artificial sort have intervened; each student singles out for himself that particular group of studies tending to his main purpose and devotes to them the most judicious amounts of relative energy. To determine natural correlations, we must go to where the pupils meet each other in every department on relatively equal terms.

[2] See note to page 273.

[3] Here so termed for brevity; really that quality is meant which causes a person to be regarded by his teachers as "clever."

[4] The opposite and more usual view, namely, that mathematics form an entirely independent faculty, will be found expounded in 331 pages "Ueber die Anlage zur Mathematik" by the well-known psychiatrist, Möbius. Similar evidence is brought by him to the effect that this talent is proportional to the development of the upper outer orbit of the eye, especially the left.

[5] As has been before mentioned, the rank of these three faculties remains ambiguous until their observational errors have been ascertained.

studies, this accuracy is indicated by the oblique italicized line, and therefore appears about equal in all cases (not in the least following the direction of the Hierarchy); but in other cases there is a large divergence on this head, which leads to important practical consequences. Mathematics, for example, has a saturation of 74 and Common Sense has one of about 96; but in actual use the worth of these indications becomes reversed, so that a subjective impression as to a child's "brightness" is a less reliable sign than the latter's rank in the arithmetic class; almost as good as either appears a few minutes' test with a monochord.

In the above Hierarchy one of the most noticeable features is the high position of languages; to myself, at any rate, it was no small surprise to find Classics and even French placed unequivocally above English (note that this term does not refer to any study of the native tongue, but merely to the aggregate of all the lessons conducted therein, such as History, Geography, Dictation, Scripture, and Repetition).

However it may be with these or any other special facts, here would seem to lie the long wanted general rational basis for public examinations. Instead of continuing ineffectively to protest that high marks in Greek syntax are no test as to the capacity of men to command troops or to administer provinces, we shall at last actually determine the precise accuracy of the various means of measuring General Intelligence, and then we shall in an equally positive objective manner ascertain the exact relative importance of this General Intelligence as compared with the other characteristics desirable for the particular post which the candidate is to assume (such as any required Specific Intelligences, also Instruction, Force of Will, Physical Constitution, Honesty, Zeal, etc.; though some of these factors cannot easily be estimated separately, there is no insuperable obstacle to weighing their *total influence* as compared with General Intelligence). Thus, it is to be hoped, we shall eventually reach our pedagogical conclusions, not by easy subjective theories, nor by the insignificant range of personal experiences, nor yet by some catchpenny exceptional cases, but rather by an adequately representative array of established facts.

6. *Outer Factors Determining the Amount of Correlation.*

The values given in the preceding section show the correlations found for various specific activities. These amounts, however, are not wholly constant; the apparent or raw correlations, as we have abundantly seen, deviate in every direction, depending almost entirely upon the number and kind of impurities suffered to enter and vitiate them; but even the true corrected correlation appears to admit of no inconsiderable variation,

according to the conditions of experiment. Generally speaking, the amount seems to be always greater in proportion as the reagents are enabled to *manifest their finest powers;* nor is such factor readily resolvable into the greater regularity thereby obtained. It is especially conspicuous in the following phenomena:

The correlation is augmented when Discrimination is calculated according to the reagents' acutest perception under the most favorable circumstances, rather than according to their freedom from accidental slips.[1] The correlation is larger when all the reagents have the function in question well developed, either by general habit or by careful fore-exercise, than when all are in a comparatively backward stage.[2] So far, this increase has only manifested itself for the lower grades of practice; it might conceivably be reversed, on approaching the higher grades of special training.

The correlation increases, when the conditions of examination are such as least to distract or puzzle the reagent.

The other factor appearing at all likely to determine the amount of correlation is Age. Within the narrow range of most of our experiments, however, namely from nine to fourteen years, this influence is not apparent. To measure exactly any such change, correlations have been calculated of a secondary order, that is, between the above correspondence on the one hand and Age on the other; even among the village children, who are still in the process of developing their sensory acuteness, this correlation of secondary order only amounts to −0.15, thus indicating that the correspondence between Discrimination and Intellect is almost as great among the older children as among the younger ones. For the boys of the preparatory school, who have already reached their full sensory powers, this secondary correlation comes to −0.07, testifying that the above correspondence is as nearly as possible uniform throughout the different ages. Finally we have seen evidence that this correspondence is the cause of the correspondence between one kind of Discrimination and another, and the latter has proved of exactly the same value for adults as for children (0.25 raw).

It must, however, be mentioned that the opinion has been arrived at and stoutly defended by Wissler, that any corre-

---

[1] This seems to indicate an opposition between the sensory acuteness due to Intelligence and that arising from Practice. This, again, would evidently conflict with Fechner's principle of measuring the sensory threshold by means of Gauss' formula.

[2] It must be mentioned that Binet has arrived at the contrary conclusion, namely that correlations with Intelligence are only observable on first trial and almost disappear when the reagents are again tested. See L'année psychologique, Vol. VI.

spondence between Intelligence and Mental Tests can only exist among young children and must disappear with advancing adolescence. He bases his view firstly upon the fact that his Columbia experiments with University students show no appreciable correlations of this nature; this argument will be dealt with in the next section, criticising these same experiments. And secondly, he truly enough remarks that even the correlations found by Gilbert in children from six years upwards are no longer evident in their seventeenth and eighteenth years. But Wissler does not seem to have been able to measure these correlations of Gilbert quantitatively, the latter not having furnished the data required for the standard formula; they may, however, easily be reckoned by means of the method of "class averages;"[1] they will then be seen to be all very irregular and throughout in dangerous proximity to the amount of the probable error; though the seventeenth and eighteenth years do indeed show little correspondence, yet the sixteenth year exhibits the very highest of all while the twelfth year has the lowest; as regards the *general* tendency of these correlations, it is really if anything to *increase* with Age (such tendency only amounts to 0.15 ± 0.08 and therefore is probably a mere chance).

7. *Previous Researches Conflicting with the Present Results.*

The great bulk of past experiments do not admit of direct comparison with the present ones; for while the latter have been expressly confined to the most elementary forms of laboratory procedure, the former have continually striven to cover vast territory so as to summarily exhaust the whole problem. These more ambitious researches, therefore, can only be criticised in the general manner attempted in Chapter II.

But three investigations—luckily such as to represent the best work accomplished in this department—have also included our present topic, simple Sensory Discrimination. These three will now be discussed in more detail.

Gilbert. The first is that of J. Gilbert, whose valuable and already frequently mentioned experiments upon over 1,000 school children in 1893 included an inquiry into "muscle sense" and "color differences." The apparatus for the former, as for my own, consisted in a number of small boxes which looked and felt exactly similar but were really a set of finely graduated weights. Also his "color differences" were very analogous to my sight tests, for both utilized a series of objects each slightly darker than the preceding one and both were executed by day-

[1] See "The Association between Two Things." This *Journal*, XV, 1904, pp. 72-101.

light.[1] His grading of "mental ability" lay in the usual classification of the children by their respective masters into "bright," "average," and "dull."

As regards his results, Gilbert is perhaps the most conspicuous among those investigators who *do* find an appreciable correspondence between "mental tests" and "general ability." Concerning the above two Sensory Discriminations, he unfortunately confines himself to the following indirect information: "The curves for reaction-time gave the most positive results showing that the brighter the child the more quickly he is able to act. *In discrimination the same relation is noticeable but to a less degree.*"[2] Thus we are referred on to the correlation for reaction-time, which is everywhere emphasized. "The difference between the reaction-time of those who were bright, of average mental ability and dull respectively" becomes "very noticeable." Again, "the bright children react much more quickly than the dull," and "it is shown here that we judge of a child's mental ability by the quickness or rapidity with which they were able to act." Though Gilbert contents himself with these utterances of rather vague character, he here carefully furnishes most of the essential data for more precise conclusions; he tells us the average reaction-time of "bright," "average," and "dull" for each of the twelve years tested; also he gives us all the mean variations.

With this knowledge, we are easily enabled to work out the exact correlation for ourselves,[3] and are surprised to find that it after all averages no more than 0.19 ($\pm$ 0.04).[4] The correlation of general ability with sensory discrimination, being even less noticeable, must indeed be minute.

To explain this low figure we must note that from the described mode of procedure the conditions would seem to have here been at least as unfavorable as they were in the present Series III. In confirmation of this view, it may be seen that

[1] This similarity of apparatus by no means implies any proportional similarity in mode of proceeding.

[2] Studies Yale Psych. Lab., II, p. 94. The italics are mine.

[3] By the method of "class averages."

[4] Here we have an illustrative instance of operating with large numbers of cases. This correlation of Gilbert was based upon an examination of no less than some 1,100 children; therewith we may compare the chief correlation in the present Series IV based on examination of only 22. To the layman, the latter result would seem the immensely more exposed of the two to the danger of being a mere chance coincidence. But when the matter is worked out precisely according to the true and established laws of chance, a correlation like that found by Gilbert, being less than four times its probable error, would occur by mere accident about once in 200 times; whereas the correlation in Series IV, being over twenty times its probable error, would not so occur in millions upon millions.

the average threshold found by Gilbert for discrimination of weight is as coarse as 1/11, whereas even that in Series III comes to 1/15 and the more carefully executed Series I shows 1/20. The natural consequence would necessarily have been to produce a similar attenuation by inadequate representativeness and therefore a similarly small correlation as in that series. Moreover, such an effect would have been materially enhanced by the heterogeneity of Gilbert's reagents, which must inevitably have introduced serious irrelevant correlation. If these considerations be justified, his observed correlations must be taken as being very much smaller than the true ones would have been.

Seashore. The next results to be criticised are those of Seashore, which include an important investigation into the same Pitch Discrimination with which our own experiments have been so much occupied. Seashore, as we have seen, comes to the resolutely negative conclusion "*that there is no functional relation*[1] between any one of these (mental tests) and general mental ability."

To support this verdict in the case of Pitch, he draws up the following table, remarking, "the distribution of the results practically coincides with the most probable distribution according to chance, which is indicated in the parentheses."

General Mental Ability.

		I	II	III	IV	V
	I	5 (5)	8 (6)	3 (7)	5 (4)	1 (1)
Discriminative	II	16 (14)	18 (16)	18 (17)	7 (10)	2 (3)
Sensibility	III	6 (8)	7 (10)	15 (10)	5 (6)	3 (2)
for Pitch.	IV	6 (7)	7 (8)	8 (9)	8 (5)	2 (1)
	V	4 (3)	3 (3)	3 (4)	2 (2)	1 (1)

But this ingenious mode of calculating correlation is of a somewhat disseminated nature, and one may be pardoned for thinking it hardly adapted for giving very accurate results. If, instead of trying to consider fifty amounts all at the same time, we sum them up a little and compare averages we shall find after all a fairly definite tendency for the higher ability to be also accompanied by higher place in Discrimination. If we desire a still more unified and really usable result, we can easily obtain it by any of Pearson's or my auxiliary method;[2] it works out by Pearson's method to 0.24 ($\pm$0.07). Thus here, where functional relation has been so categorically denied, it is in reality greater than in Gilbert's reaction-times where it was held up as being so complete.

---

[1] The italics are Seashore's.

[2] Seashore's data are not sufficient for us to apply the standard formula.

But this value, though plain and positive enough, must nevertheless be admitted to be somewhat small as compared with that in my own experiments. Nor can this be altogether explained in precisely the same way as in the last example, for here the method of procedure seems to have been much more deliberate; the experimentation was skillfully designed, and the seven minutes allowed to each reagent was perhaps sufficient for its proper execution, though about a quarter of an hour appears to me better. But when we consider the composition of the sample of persons experimented upon, we come upon an irrelevant correlation of great magnitude; for we find that though Seashore remarks a great discrepancy between the children under and over ten years of age, yet he throws them all together into the same correlation and thus introduces an irrelevant connection with Age which comes to no less than 0.73 (reckoned again by Pearson's auxiliary method). This irrelevancy has evidently just the same effect, whether it be really due to difference of age; or, as I have suggested, partly to disparity of culture; or even, as Seashore himself supposes, to imperfection of experimentation. In all cases alike, the real correlation comes to about 0.35,[1] which is almost exactly the same result as obtained in my own Series I before allowing for further errors.[2]

Columbia. We now pass to the third and last series of experiments bearing on our particular question. This is the very extensive and in many respects important one that has been continuously conducted at Columbia University for the past ten years. For our present purpose, it includes "Perception of Weight" and "Perception of Pitch," while an intellectual grading is obtained from the students' average standing in the various university courses.

Again the general conclusion is an unqualified negative, reading as follows:

"The markings of the students in college classes correlate with themselves to a considerable degree, but not with those made in the laboratory."

Here our critical review is rendered much simpler by the correlations having been properly calculated and plainly stated. Wissler's statement is fully borne out by the values quoted,

---

[1] $$\frac{0.24}{\sqrt{1 - 0.73^2}} = 0.35$$

[2] Once more Dr. Seashore has an easy opportunity of practically testing these theoretically gained conclusions concerning this work; if he will exclude the disparate cases under ten years of age, and still more if he will then confine his consideration to such as have learnt music, he will be able definitely to ascertain whether or not the correspondence does not thereupon become very apparent.

the average correlation of the tests with Intelligence being only 0.06 and that of the tests among themselves being 0.09, thus in neither case much exceeding the size of the probable error, though the great majority of instances are at any rate positive. The amount for Perception of Weight is unfortunately not given, but that for Perception of Pitch comes to 0.16.

Above we have seen that Wissler would account for this minuteness of correspondence by the greater age of the students as compared with the children usually experimented upon. But so far our available evidence is not at all that correspondence diminishes with age, but rather that it is completely independent thereof. Moreover there does not appear any urgent need of introducing such a factor, seeing that perhaps sufficient explanation is forthcoming otherwise. To begin with, university students are not exactly the average from the schools but more or less a selection of the most able; hence they intellectively form a more homogeneous class, so that all their intellective correlations will be somewhat reduced in amount. More serious, probably, is the fact that the test of Discrimination has here been so impurified by alien elements, that even Wissler himself prefers to call it a test of Memory.

But perhaps the chief source of the lowness of the correlations will be found in the following circumstances, namely: that the subjects were examined three at a time, each being managed by some "student or officer of the department;" that no less than twenty-two different tests were carried out, many of a most difficult character, besides measuring the length and breadth of each reagent's head; that during the leisure moments afforded him in the course of these tests the observing "student or officer of the department" had to note in writing the contour of the reagent's forehead, the character of his hair, the nature of his complexion, the color of his eyes, the shape of his nose, the description of his ears, of his lips, of his hands, of his fingers, of his face, and of his head—and that this whole procedure is considered to be satisfactorily completed in forty-five minutes.

On the whole, then, the apparent conflict of previous researches with the present ones does not appear fundamental or such as in any way to invalidate the evidence now produced.

8. *Summary of Conclusions.*

To conclude, the following is a brief summary of the principal conclusions indicated by the foregoing experiments:

I. The results hitherto obtained in respect of psychic correlation would, if true, be almost fatal to experimental psychology as a profitable branch of science. But none of these results, as at present standing, can be considered to possess any

value other than suggestive only; this fact is not so much due to individual shortcomings of the investigators, as to the general non-existence of any adequate system of investigation.

II. On making good this methodological deficiency, there is found to actually occur a correspondence—continually varying in size according to the experimental conditions—between all the forms of Sensory Discrimination and the more complicated Intellectual Activities of practical life.

III. By this same new system of methodics, there is also shown to exist a correspondence between what may provisionally be called "General Discrimination" and "General Intelligence" which works out with great approximation[1] to *one or absoluteness.* Unlike the result quoted in the preceding paragraph, this phenomenon appears independent of the particular experimental circumstances; it has nothing to do with the procedure selected for testing either Discrimination or Intelligence, nor with the true representativeness of the values obtained by these tests, nor even with the homogeneousness of the experimental reagents; if the thesis be correct, its proof should be reproducible in all times, places, and manners—on the sole condition of adequate methodics.

IV. The above and other analogous observed facts indicate *that all branches of intellectual activity have in common one fundamental function (or group of functions), whereas the remaining or specific elements of the activity seem in every case to be wholly different from that in all the others.* The relative influence of the general to the specific function varies in the ten departments here investigated from 15:1 to 1:4.

V. As an important practical consequence of this universal Unity of the Intellectual Function, the various actual forms of mental activity constitute a stably interconnected Hierarchy according to their different degrees of intellective saturation. Hence, the value of any method of examination as to intellectual fitness for any given post is capable of being precisely ascertained, since it depends upon:

(a) the accuracy with which it can be conducted;

(b) the hierarchical intellective rank of the test;

(c) the hierarchical intellective rank of the duties involved in the post.

Methods have been given whereby all these three points can be sufficiently ascertained.

VI. Discussion as to the psychical nature of this fundamental Function has been reserved until a more complete acquaintance has been gained concerning its objective relations. Among the latter, the principal and determining one is its

[1] In the present experiments, as far as the second decimal place.

unique position as indicated in paragraph IV. The chief further evidence is to the following effect:

The function appears to become fully developed in children by about their ninth year, and possibly even much earlier. From this moment, there normally occurs no further change even into extreme old age.

In adult life, there would seem no appreciable difference between the two sexes.

The Function almost entirely controls the relative position of children at school (after making due allowance for difference of age), and is nine parts out of ten responsible for success in such a simple act as Discrimination of Pitch.

Its relation to the intellectual activity does not appear to be of any loosely connected or auxiliary character (such as willingness to make an effort, readiness in adaptation to unfamiliar tests, or dexterity in the fashion of executing them), but rather to be intimately bound up in the very essence of the process.

APPENDIX.

Experimental Series I.

Village School, 24 Oldest Children.

A. Original Data.

Sex.	Age.		Discriminative Threshold.			Intellectual Rank.		
	Years	Months	Pitch 1/3 v. d.	Light 1:200	Weight 1:200	Common Sense out of School. (A)	(B)	Cleverness in School.
f	11	6	8	4	[illegible]	6	5	2
m	12	11	15	3	4	11	7	22
f	12	8	14	6	4	16	10	7
f	13	8	13	4	9	1	1	1
m	11	4	5	14	7	3	2	[illegible]
f	11	11	25	7	4	10	14	9
f	11	3	10	19	8	8	19	12
f	13	1	10	12	10	2	4	6
m	12	5	18	11	9	5	6	11
m	12	7	14	30	7	21	22	19
f	12	8	60	3	10	12	9	4
f	13	10	20	12	10	13	12	18
f	13	1	40	5	12	4	8	8
f	12	1	45	12	9	9	13	14
f	10	6	33	3	15	15	18	10
m	11	5	25	4	28	17	11	17
m	10	0	90	15	5	22	21	5
f	11	9	17	15	20	14	20	15
m	13	7	24	26	13	19	17	24
m	12	6	18	35	14	18	3	6
m	10	4	70	10	14	23	24	20
m	11	7	17	42	16	24	23	23
f	11	2	28	20	17	7	15	13
m	11	2	90	25	18	20	16	21

EXPERIMENTAL SERIES I.

Village School, 24 Oldest Children.

B. Calculated Correlations.

Description.		Amounts.		
First Term *versus*	Second Term.	Raw.	Prob. Err	Corrected.
Sound Discrim.	Common Sense (A)	+0.44	0.07	
" "	" " (B)	+0.41	0.07	+0.71
" "	School Cleverness	+0.25	0.09	
Light "	Common Sense (A)	+0.42	0.07	
" "	" " (B)	+0.44	0.07	+0.58
" "	School Cleverness	+0.47	0.06	
Weight "	Common Sense (A)	+0.38	0.07	
" "	" " (B)	+0.27	0.08	+0.43
" "	School Cleverness	+0.37	0.07	
Com. Sense (A)	Common Sense (B)	+0.64	0.05	
Common Sense	School Clever. Av.	+0.55	0.04	+0.86
Discrimination	Discrimination "	+0.25	0.05	+0.39
"	Intelligence "	+0.38	0.02	+0.86
"	Amal. Intell. "	+0.66	0.04	
"	Sex "	+0.21*	0.09	+0.00
Sex	Intelligence "	+0.47*	0.06	+0.59
Age	Sound Discrim.	+0.41	0.07	
"	Light Discrim.	+0.30	0.07	+0.18
"	Weight Discrim.	+0.70	0.09	
"	Intelligence Av.	+0.34	0.05	+0.38
"	Corr. Discrim.-Intell.	+0.15	0.09	+0.00
General Intell.	Pitch Discrim.			+0.72
"	Light "			+0.57
"	Weight "			+0.44
"	Common Sense			+0.98
"	School Cleverness			+0.90
"	General Discrim.			+1.00 (p e about 0 02)

The probable error may be taken at about 0.10

*These two correlations have had to be calculated by an auxiliary method, the standard formula not being applicable; hence, the probable error is considerably larger than it would otherwise have been.

Experimental Series II.

Same Village School, 36 next Oldest Children.

A. Original Data.

Sex.	Age.		Pitch.	Intellectual Class estimated by Schoolmaster.
m	9	7	6	1
m	8	7	6	2
f	7	3	16	1
m	8	0	24	2
f	8	0	26	2
m	8	4	35	2
m	9	9	35	3
m	8	2	38	1
m	9	0	42	3
f	7	11	48	2
f	8	2	48	2
f	7	2	67	1
f	9	11	67	3
*f	5	8	70	
*m	5	7	74	
m	10	2	74	2
*m	7	0	77	
f	7	1	77	1
*f	6	9	80	
m	9	6	80	3
m	7	10	96	1
m	8	2	96	1
*m	6	7	104	
*f	6	10	112	
m	7	11	112	2
*m	5	6	120	
*m	5	11	120	
*m	6	6	120	
*m	6	5	> 120	
f	7	0	> 120	1
*f	6	5	> 120	
*m	6	1	> 120	
m	7	3	> 120	1
*m	5	6	> 120	
*m	6	6	> 120	

Those marked with a star are in the infant school; their relative intellectual rank has not been ascertained, and therefore they are not included in the correlations below. Their average threshold is about 40 v. d., or more than double that of the remainder.

B. Calculated Correlations.

Description.			Amounts.		
First Term	*versus*	Second Term.	Raw.	Prob.Err.	Corrected.
Pitch Discrim.		Intellectual Class	−0.25	0.18	+0.41
Age		Pitch Discrim.	+0.55	0.18	+0.69
"		Intellectual Class	−0.65	0.18	−0.81

EXPERIMENTAL SERIES III.

High Class Preparatory School for Boys.

A. Original Data.

Age.		Discriminative Threshold.			Place in School (*before modification to eliminate Age*).			
		Pitch From Ex Ser. IV.	Light 1:200	Weight 1:200	Classics	French	English	Mathem.
10	9	50	10	4	16	19	10	7
12	4	3	10	6	5	6	6	5
11	1	10	10	9	13	11	11	13
10	11	> 60	10	9	22	23	22	22
13	7	4	12	5	1	[illegible]	1	2
12	6	2	10	10	4	2	2	1
10	4	4	10	11	12	14	13	18
9	5	20	10	11	23	22	23	23
12	0	11	10	12	8	[illegible]	15	15
10	2	11	12	11	3	5	4	4
11	2	24	14	10	7	7	7	6
10	1	5	18	7	20	15	18	16
9	8	3	18	9	10	13	14	12
11	10	5	13	13	2	3	3	3
11	1	6	13	13	11	12	12	9
10	6	[illegible]	14	11	17	18	17	13
10	8	15	19	10	21	20	21	19
10	4	11	14	13	19	21	9	21
10	4	14	13	18	18	16	8	17
10	1	15	13	[illegible]	15	10	[illegible]	10
12	3	7	19	13	9	[illegible]	16	11
10	7	4	16	16	14	17	19	20
13	7	> 60	19	27	6	4	5	8

B. Calculated Correlations.

Description.		Amounts.	
First Term. *versus*	Second Term.	Raw.	Prob. Error.
Amal. School Place*	Light Discrimination	+0.13	0.09
" " "	Weight "	+0.12	0.09
" " "	Amal. Light and Weight	+0.19	0.06
Weight Discrim.	Light Discrim.	+0.32	0.08
Pitch "	Weight "	+0.16	0.09
" "	Light "	+0.13	0.09
Age "	Weight "	+0.09	0.09
" "	Light "	+0.14	0.09

*Modified to eliminate age.

Experimental Series IV.

High Class Preparatory School for Boys.

A. Original Data.

Age		Pitch	Place in School (*before modification to eliminate Age*).												Music
			Classics			French			English			Mathem.			
Years	Months	Discrim. Thres. in ½ v. d., October, 1902	Xmas, 1902	Easter, 1903	July, 1903	Xmas, 1902	Easter, 1903	July 1903	Xmas, 1902	Easter, 1903	July, 1903	Xmas 1902	Easter, 1903	July, 1903	Ranked by Music Master
12	6	[illegible]	8	7	4	5	3	3	4	3	3	4	2	3	8
12	4	3	11	12	10	13	13	10	13	13	11	12	13	11	9
9	8	3	19	18	15	21	19	16	23	21	18	21	19	17	6
13	7	4	2	2	[illegible]	2	[illegible]	1	2	[illegible]	1	7	[illegible]	7	3
10	4	[illegible]	21		19	22		23	22		20	[illegible]		24	16
10	7	4	23	23	22	26	23	22	28	25	23	29	25	23	[illegible]
13	6	5	3			3			3			3			21
11	10	[illegible]	6	4	3	7	6	5	6	[illegible]	2	9	[illegible]	6	
10	1	5	29	26	24	23	25	[illegible]	27	26	22	25	23	19	7
11	1	6	20	20	18	20	21	18	21	20	19	17	16	15	14
13	4	7	1	1		[illegible]	1		1	1		1	1		5
10	6	7	26	24	21	27	16	13	26	19	17	22	18	16	11
12	3	7	18	17	16	17	20	19	25	23	21	19	17	14	20
13	1	8	5	[illegible]	5	[illegible]	4	2	5	8	5	[illegible]	4	1	[illegible]
11	1	10	22	19	17	19	18	17	20	17	15	23	21	21	18
9	9	10	33	29	27	33	29	27	33	27	27	32	29	27	17
10	4	11	28	25	23	30	27	24	18	18	13	30	27	22	
13	0	11	4	3	2	6	5	4	7	4	4	2	3	4	
10	2	11	7	6	6	12	7	[illegible]	8	5	[illegible]	11	9	8	
13	0	11	12	11	11	11	11	12	15	16	16	6	5	2	[illegible]
12	0	11	17	16		16	15		24	22		24	24		15
12	11	12	9	[illegible]	7	[illegible]	8	7	9	7	7	14	12	12	
13	1	14	10	9	8	10	[illegible]	8	11	10	9	10	10	9	13
10	4	14	27	21	14	24	22	15	17	11	10	26	20	18	2
10	1	15	24	22	20	18	17	14	29	24	24	18	15	13	
12	6	15	14	13	12	15	14	11	[illegible]	9	6	8	6	[illegible]	10
10	8	15	30	27		29	26		30	29		28	26		
12	8	18	16	15	13	25	24	[illegible]	14	14	12	20	21	20	19
9	5	20	32		25	31		25	32		26	33		26	
11	2	24	15	14	9	14	12	9	16	15	14	13	11	10	
10	9	50	25			28			19			15			
10	11	> 60	31	[illegible]	26	32	28	26	31	28	25	31	28	25	22
13	7	> 60	13	10		9	10		12	12		16	14		

Experimental Series IV.

High Class Preparatory School for Boys.

B. Calculated Correlations.

Description.				Amounts.		
First Term	*versus*	Second Term		Raw	Prb Err.	Corrected
Pitch Discrimination		Av. School Place (unmodified)		+0.33	0.04	+0.45
" "		Classics (modified to eliminate age)	Av.	+0.60	[illegible]	
" "		French " " "	"	+0.56	0.03	
" "		English " " "	"	+0.45	0.03	
" "		Mathematics " " "	"	+0.39	0.03	
" "		Classics (musicians only)[1]	"	+0.66	0.03	+0.89
" "		French " "	"	+0.65	0.03	+0.88
" "		English " "	"	+0.54	0.03	+0.73
" "		Mathematics " "	"	+0.45	0.03	+0.61
" "		Amal. School Place (musicians only)	"	+0.68	0.01	+0.87
Classics		Classics	"	+0.87	0.01	
French		French	"	+0.84	0.01	
English		English	"	+0.89	0.01	
Mathematics		Mathematics	"	+0.88	0.01	
Amal. School Place		Amal. School Place	"	+0.95	0.01	
Classics		French	"	+0.83	0.01	+0.96
"		English	"	+0.78	0.01	+0.91
"		Mathematics	"	+0.70	0.01	+0.81
French		English	"	+0.67	0.01	+0.78
"		Mathematics	"	+0.67	0.01	+0.78
English		Mathematics	"	+0.64	0.01	+0.74
Age		Amal. School Place (unmodified)	"	+0.76	[illegible]	+0.78
"		" " " (modified)		+0.05	0.05	
"		Pitch Discrim.		—0.07	0.08	+0.00
"		Corr. Discrim.-Intell.		—0.07	0.08	
Music		Classics	Av.	+0.63	0.03	+0.85
"		French	"	+0.57	0.03	+0.77
"		English	"	+0.51	0.03	+0.69
"		Mathematics	"	+0.51	0.03	+0.69
"		Pitch Discrimination		+0.40	[illegible]	+0.63
General Intelligence		Classics				+0.99
"		Pitch Discrimination				0.94
"		French				0.92
"		English				0.90
"		Mathematics				0.86
"		Music				0.70
Amal. School Place		Music and Pitch Discrim.	Av.	+0.72	[illegible]	
General Intelligence		*General Auditory Faculty*				*1.00* (p. e. about 002)

The probable error does not here seem over 0.05 at most.

[1]All School Places below this point refer to the musicians considered alone.

Experimental Series V.

Adults.

A. Original Data.

Reagent	Sex.	Age.	Pitch 1/3 v. d.	Light 1:200	Weight 1:200	Remarks.
m[1]	f	27	3	4	8	
n[2]	f	23	7	7	6	
s[3]	m	39	2	3	15	Psychologist, experimental
v[4]	m	55	7	[redacted]	6	Plays violin
m	m	53	6	5	8	
v	m	69	[redacted]		10	Maker of musical handbells
n	f	24	10	8	2	
m	f	45	7	8	8	
n	f	21	10	8	6	
m	f	22	10	3	16	
n	f	22	10	12	4	
s	m	78	5	8	30	Has unusually pronounced
m	f	30	7	24	8	calcareous degeneration
m	f	30	15	4	12	of the arteries
v	f	52	27	5	10	
v	[redacted]	45	65	[redacted]	[redacted]	
v	f	40	15	6	15	
m	f	30	12	48	6	
[redacted]	f	[redacted]	15	8	16	
n	m	50	30	15	10	
s	[redacted]	21	10	20	14	Has bad epilepsy
v	f	[redacted]	100	6	14	
s	m	40	100	8	12	Extraordinarily slow thinker
v	m	25	30	15	18	The village organist
n	f	40	30	20	28	
v	m	40	80	12	19	
v	m	40	180	11	9	

[1] m indicates (in this column) that the reagent has been specially selected on account of remarkable musical talent; 5 are amateurs and 2 are professionals.

[2] n indicates normal and the reagents may be regarded as fairly typical of the class termed "well educated," they contain about their average proportion of musical ability.

[3] s indicates specially selected for some characteristic mentioned in the column of remarks.

[4] v indicates well-to-do villagers.

B. Calculated Correlations.

Description.			Amounts.		
First Term	*versus*	Second Term	Raw.	Prob. Err	Corrected.
Pitch Discrim.		Light Discrim.	+0.32	0.08	
" "		Weight "	" 0.31	0.08	+0.39
Light "		" "	" 0.11	0.08	
Age "		Pitch "	" 0.07	0.08	
" "		Light "	" 0.15	0.08	0.00
" "		" "	−0.14	0.08	

CORRECTIONS TO "MEASUREMENT OF ASSOCIATION."

Page 84 In first equation dele "$\frac{3a-b}{2a+b}$" and subs. "$\frac{3}{2} \cdot \frac{a-b}{a+b}$"

Note 1 should be

"More accurately, $r = \sin \frac{\pi}{2} \cdot \frac{a-b}{a+b}$

Hence, when the correlation is very complete, etc., etc."

Page 85 Dele "More accurately, $r = \sin \frac{\pi}{2} \cdot \frac{a-b}{a+b}$"

LITERATURE.

The British Journal of Psychology. Edited by James Ward and W. H. R. Rivers, with the collaboration of W. McDougall, C. S. Myers, A. F. Shand, C. S. Sherrington, W. G. Smith. Vol. I, Part I. January, 1904. C. J. Clay and Sons, London. pp. 115.

Besides the editorial this first number contains the following articles: James Ward, On the Definition of Psychology; C. S. Sherrington, On Binocular Flicker and the Correlation of Activity of "Corresponding" Retinal Points; J. Lewis McIntyre, A Sixteenth Century Psychologist, Bernardino Telesio, W. McDougall, The Sensations Excited by a Single Momentary Stimulation of the Eye; W. McDougall, Note on the Principle underlying Fechner's "Paradoxical Experiment" and the Predominance of Contours in the Struggle of the two Visual Fields, Proceedings of the Psychological Society.

This journal will be issued in parts at irregular intervals, and a volume consisting of about four hundred and fifty pages costs fifteen shillings in advance, single numbers, five shillings.

The American Journal of Psychology welcomes most heartily the new British Journal of Psychology and congratulates it upon its almost ideal form both in type and page. Its establishment ought to mark an epoch in the development of British thought as important as that marked by the establishment of Mind by the late Croom Robertson and Mr. Bain many years ago. The difference of standpoint between the first numbers of these two journals is typical of the tendencies of modern thought in this field. In the editorial we are told that there are about half a dozen lectureships already established to promote the study of psychology as a science, that psychology is independent of the control of philosophy, having its own methods, problems and standpoint, that ideas "in the philosophical sense do not fall within its scope: its inquiries are restricted entirely to facts. In pursuit of these it is brought into close relations with biology, physiology, pathology, and again with philology, anthropology, and even literature. Its results, also, have important, practical applications for the educationist, the jurist, the economist, quite apart from their theoretical bearing on the problems of the epistemologist and the moralist." It is to be "devoted exclusively to psychology in all its branches, analytical, genetic, comparative, experimental, pathological, individual, ethnical, etc." It aims to serve as an organ "for all alike who are working in any one of the many branches into which psychology has differentiated." "Among the standards by which communications will be judged, that of length will not be one."

The articles of Sherrington and McDougall are admirable laboratory investigations on optical phenomena, well calculated to show the great advantages of work with instruments to advance self knowledge even of elementary sense activities which introspection could never attain without the aid of these methods. The historical study on Telesio is an interesting picture of a sixteenth century man who regarded human nature a part of nature subject to natural laws and to be developed by purely empirical methods. The article of James Ward is written from a very different standpoint which, to the writer of this note, seems both effete and sterile. He tells us how Aristotle and then how Descartes regarded psychology and of the great change that has lately supervened from the conception of the soul as a *res cogitans*, which

had in a sense further development in the panlogism of Hagel, to the more efferent conceptions illustrated by Kant's "Critique of the Practical rather than the Pure Reason, by Schopenhauer," etc., and how this reaction against intellectualism has lately been extended and confirmed by evolutionary and experimental studies which insist that the will rather than the intellect is our clue in understanding experience, how this makes knowledge no longer an end in itself but always a means. He finally concludes that "in every case physiological and comparative psychology must fall back on the facts and analogies of our own experience." The view that begins with mechanism and ends with mind gives the experient only a presentational kind of physiological psychology of the worst sort, "where physiological and psychological conceptions are forever coquetting with each other, and where, as a result, unseemly hybrids are not infrequent," like Huxley's "Ideagenous Molecules."

Now, all this seems to us trite, barren, obsolete and irrelevant. There is no more patent and commonplace fact in the psychological world than this great transition, and nothing that the student of mind is so ready to admit as that man is indefinitely more anthropomorphic than he knows and must forever judge and know everything in terms of his own psychic activities. But one of the chief claims of experimental, genetic, and comparative psychology is that it sheds new light upon our own activities which the arm-chaired introspectionist who turns his mental eyes inward has grown impotent to add to. The other papers in this first number make contributions of what was unknown before to the modern reader. This adds nothing. In fact the introspectionist of this type has ceased to interest the progressive, modern student of mind, except that his writings are precious documents of a unique type of mind. The mortgage the epistemologist always demands the experimenter to cancel is essentially a spurious one. The limitations he lays down, the definitions in which he is so profuse, the stepmotherly anxiety lest the laboratory man should make some *faux pas* or perturb his circles, suggests that the true "hybrid" is the epistemologist who attempts to legislate for experimentation in which he has no practical experience. The very life of the new psychology depends upon whether it can throw off the leading strings of the old sufficiently to secure its own free movement. It is preposterous, at present, to define psychology save as Bleek long ago undertook to define philology: *es ist was es wird*. It is in a process of rapid development. It has so many lines and departments that if it could be correctly described to-day all the definitions might be outgrown to-morrow. None but an almost paranoiac systematism would attempt to write even a logic or a methodoloy for it. As grammar comes after the golden period of language and literature, so these things must come when the present enormous expansion of psychology in all its departments is approaching the end of a period. The new movement owes all its achievements to the method of treating psychic activities as natural phenomena and as well might a speculative materialist attempt to "hold up" or cast suspicion on the actual laboratory work of physics and chemistry, because no one knows just what an atom, a vortex, or ether really is, as the epistemologist obtrude his scholastic scruples into the domain of psychology as a science. H.

Grundzüge der Psychologie, Band I. Allgemeiner Teil. Die Prinzipien der Psychologie. von HUGO MUENSTERBERG. Leipzig, J. A. Barth. 1900. pp. XII+565. 12M.

This first volume of a treatise upon which Professor Münsterberg is engaged, deals only with the fundamental principles and general problems of psychology. While it is for that reason introductory in scope

and character, yet it is in a measure complete in itself. The forthcoming part of the work will round off the author's system with a discussion of the special problems of individual and social psychology.

Professor Münsterberg's point of view is already familiar to readers of his "Psychology and Life." The rapid progress of the sciences in the nineteenth century, and the wide-spread interest which they excited, turned contemporaneous thought into a naturalistic channel. The scientific method was extended to more and more disciplines; scientific explanations were pressed into ever-widening fields. This tendency attained such impetus that its influence is felt upon the thought of the present day. Its dominant characteristics are lack of criticism and absence of systematization. Sound philosophy has been dethroned and naturalism reigns in her stead. The movement has left psychology in a deplorable condition. There has been a thirst for facts and particular details with but little desire for a systematized body of knowledge. Moreover the psychologist's zeal for the amassing of facts has led him to ignore the epistemological and metaphysical principles involved in his search. His method of procedure has been left to the guidance of instinct; he has been guilty of every crime in the philosophic calendar.

Now the psychologist is clearly within his rights in refraining from constructing a system. But if his solution of the problems is even to approximate finality he must be discreet in his choice of methods and discriminating in his use of concepts. It is essential, then, that we go back to first principles and look well to our foundations before we proceed to build upon them. The psychologist must be sure he is right before he goes ahead; it is Professor Münsterberg's purpose not only to show him that he is wrong but to set him right. Hence the present volume is not concerned with a re-enumeration of the particular facts of psychology. Its object is more fundamental and preparatory; it aims to ensure future progress and to safeguard future results by subjecting the foundations of the science to a critical examination. It is the vanguard of the oncoming army of psychologists; its mission is to map out a safe line of march and to establish a secure base of operation. But besides laying down an epistemological foundation for psychology by a critical examination of the fundamental concepts, assumptions, limits and ideals of the science, it emphasizes the necessity of a systematization of psychological knowledge.

Professor Münsterberg champions the cause of idealism as against the prevailing positivistic tendency. The book is a polemic against the "positivistic view of the world which grows out of psychology itself in more and more threatening form;" its author disclaims any disposition on his own part to "elevate psychology to the rank of a positivistic philosophy." As a metaphysician Professor Münsterberg is an ethical idealist of the Fichtean school; as a psychologist he is an atomist of the most extreme mechanical type. He promises a synthesis of these two positions; not, however, by inconsistent compromises on either side, but a higher synthesis which will do strict justice to idealism while it guarantees the most complete freedom to experimental psychology.

He begins his task by working out a classification of the sciences from the basis of the antithesis between causality and teleology. He recognizes two distinct types—the objectifying and the subjectifying sciences. Sciences of the first type deal with a subject-matter which is regarded as mere meaningless existence, while in those of the second type the datum has meaning or value for the subject. Scientific procedure in the former case consists in defining the character of the meaningless objects and discovering their causal relations. The sub-

jectifying sciences have to do with the subject's taking up definite attitudes toward significant objects; scientific procedure here consists in interpreting and evaluating the objects, never in determining their causal connections. Physics and psychology fall under the objectifying category, while history, ethics and æsthetics are representatives of the subjectifying group.

Within each of these groups appears a second bipartition, based upon the degree of community of the object. Certain objects regarded as unmeaning existences, are the common experience of several individuals, and are for that reason assigned to physics. Other meaningless objects constitute the subject-matter of psychology, in virtue of the fact that they are the peculiar possession of but a single individual. The same distinction is carried through the subjectifying sciences, where the individual acts of will of the position-taking subject are set over against his common or over-individual acts of will. The latter fall within the province of the normative sciences while the former become the material of the historical sciences. The two scientific methods remain distinct throughout. It is the business of the objectifying sciences to *explain* by a process of tracing out causal sequences. The subjectifying sciences make no use of the concept of causality; it is their business to *understand*, by a process of interpretation and evaluation.

It is to be borne in mind, however, that the sciences do not deal with real experience. Primary experience is transformed and made over for scientific purposes—a transformation which differs in kind for each of the various classes of science. For while one science regards its transformation product as a bare non-significant existent, another treats its product as a significant content whose meaning and value are to be unfolded. Moreover it is the employment of this transformation process which differentiates the man of science from the practical man of real life. It is only in the affairs of real life, as opposed to the scientific pursuits, that we have to do with reality. The sciences deal with fictitious objects arbitrarily abstracted from the world of reality for purposes of scientific expediency.

An examination of the psychical object—this meaningless mental process which has been marked off from all other objects as the material with which psychology is to deal—reveals the fact that it is even more unlike other objects than has commonly been supposed. It is non-temporal and non-spatial in character; none but physical objects are in space and time. It is also devoid of quantitative attributes. It is not subject to measurement, nor has it any causal connection with its fellows. In short, it possesses the single attribute of quality.

Psychical objects, then, constitute a series—or a number of series,—each of whose terms is distinguished from every other by qualitative differences only. It has been customary in psychology to assume that variation of sensation runs parallel with variation of physical stimulus, *e. g.*, to correlate pitch, tonal intensity and clang tint with the length, the amplitude and the form, of the sound-wave; and thus to find a physical basis for the classification of the differences of sensation. But the complexity of the relations obtaining between stimulus and sensation, together with our almost total ignorance of the intervening brain process, makes this basis of classification hazardous and undesirable. It is proposed, therefore, to work out a classification based solely upon the material of the psychical series themselves. All qualitative differences are first subdivided into three classes—differences of content-quality, of form-quality and of value-quality. Within each class again are found characteristic differences in accordance with which the members of the class may be seriated in various dimensions.

The list of possible dimensions of the first class includes kind, intensity and independence, *i. e.*, the degree to which the individual sensation resists fusion and loss of identity on entering into combination with others. Variations of form-quality also show well-marked dimensional directions of kind of form (spatial and temporal), intensity of form, and independence of form. The value-qualities constitute a more multiform series of dimensions, to which belong values of vividness, of pleasantness-unpleasantness, of spatial direction, of temporal direction and others.

As a result of the utter poverty of relations manifested by mental processes they cannot be explained or even described, save by an indirect means. The assumption of a strict psychophysical parallelism furnishes a solution of this problem. The psychical process may be described and explained by stating the physical conditions under which it arises and the physical effects which follow upon it. The discussion of the principle which Professor Münsterberg adopts as the touch-stone of psychological explanation—his Action Theory—constitutes what will doubtless prove to be the most valuable portion of his book.

Before he formulates the action theory he prepares the way by a detailed criticism of associationism and apperceptionism, which he proposes to supplant. He recognizes the heroic service rendered by the theory of apperception in the history of psychology—a service which consisted in combating the overestimation of associationism. Yet the theory of apperception must be rejected because no purely sensory theory can do justice to the wealth of mental content, nor can it, from the very nature of the case, account for the phenomenon of inhibition. Moreover, it is unscientific in that it applies the category of teleology to a purely causal series. The association theory is no less inadequate. In the first place it furnishes no physiological substrate for variations of psychical elements other than changes of quality and intensity. The varying degrees of vividness or forcibleness are left unaccounted for. And in the second place it gives no clue as to the mechanism which selects the psychophysical excitation, *i. e.*, it does not explain why this particular sensation and not another has been facilitated and endowed with greater vividness. The fundamental process which it sets out to explain is left to the guidance of accident; only the final effect is described in physiological terms. Its fatal defect, in short, is its failure to give a psychophysics of vividness-values. Yet the theory of association is sound in principle and is acceptable so far as it goes. It must, however, be supplemented by the introduction of an auxiliary factor if it is to become a satisfactory psychological theory. It has already been pointed out that no merely sensory theory can furnish an adequate basis for the explanation of all psychical phenomena. Inhibition, for example, can come about only through the opposition and counteraction of antagonistic factors. Now, there are no two ideas which as psychical processes exclude each other; there are no two sensations whose nature is such that they cannot occur in consciousness together. Psychological explanation must, therefore, have recourse to the motor functioning of the organism. The paired arrangement of the muscular mechanism furnishes just such a system of antagonistic factors as is required. Every flexor is opposed by an extensor; the contraction of the one, means the absence of contraction in the other.

The problem which the action theory attempts to solve is one of the most important, and one of the most elusive in the whole field of psychology. How are the familiar facts of facilitation and inhibition to be explained? What determines the varying degrees of vividness of

sensations? Why, in a given case, is this sensation and not another facilitated or inhibited?

Professor Münsterberg's action theory takes over from the theory of association the following theses: Sensation is the sole content of consciousness; the quality of sensation depends upon the spatial position of the sensory area of the cortex which is stimulated; the intensity of the sensation depends upon the strength of the excitation which is conducted to the cortex. Here he introduces a new factor—the centrifugal excitation which passes from the cortex to the motor apparatus—and sets up a new thesis: the sensation depends for its vividness upon the intensity of the centrifugal or motor excitation. It is assumed, then, that the sensory excitation as such, is not attended by a psychical process but enters consciousness only on being transformed into motor discharge. Sensory excitation without discharge corresponds to the minimal degree of vividness—to total inhibition of sensation. And the more complete the discharge, the more vivid and forcible the sensation. In every case the possibility of motor discharge is the *sine qua non* of the psychical process. The motor discharge, in turn, is itself conditioned by the molecular disposition of the efferent path.

A physiological basis is furnished for the theory in the paired arrangement, and the reciprocal antagonism of the motor centres. Every motor centre has a corresponding, but antagonistic motor centre. When either member of the pair is stimulated to action, the other member is, by that very fact, condemned to inactivity. This opposition of motor functioning is the basis of all facilitation and inhibition, of all selecting and discarding of psychical processes.

The action theory may be stated baldly as follows: Every mental process is constituted from two factors—sensory and motor. Without the co-operation of motor as well as sensory factors, sensation itself is impossible. The vividness of the sensation depends upon the sensory excitation at the cortex finding an unobstructed path of discharge leading down from the cortex to the sub-cortical motor centres. The excitation of any sub-cortical motor centre is attended by an inhibition of the antagonistic motor centre. Hence it follows that sensations are vivid and forcible in inverse ratio to the amount of resistance which the path of discharge of the sensory excitation encounters in the sub-cortical centres to which it leads. When the discharge of the sensory excitation meets with no resistance, the sensation enters consciousness with maximal vividness; when the path is totally blocked complete inhibition results, and the excitation fails to cross the threshold of consciousness.

This formulation of the action theory, however, gives only its schematic outline. The mental economy is much more complex than our envisagement has shown it to be. Each motor centre is correlated not only with a single antagonistic centre, but with many others besides. As a result of this complex network of co-ordinations, the motor impulse from any centre is in more or less intimate reciprocal relation with a host of other motor impulses from other centres. Moreover practice, fatigue, habit and the like, make themselves felt throughout the system, by effecting various readjustments of co-ordinations. Although motor functioning is enormously complicated by these interrelations, on the one hand, and by the acquisition of these readjusted co-ordinations, on the other, yet the principle of action remains the same throughout. The sensation, or the movement which finally arises in any given case is invariably the joint product of the total motor dispositions and the present sensory excitations.

The possibility of the excitation passing out by way of different

paths of discharge, has not been considered as yet. It is evident, however, that a variation of exit is far from being impossible. The minute anatomy of the cell, and the nature of the chemical processes which take place within the cell, are but little known. But it may well be, that the varying degrees of intensity of excitation, the different kinds and amounts of simultaneous action in other cells, the changing state of cellular nourishment and of resistance in subordinate paths, may serve to switch the motor discharge along different routes. There is ground, then, for setting up yet another thesis, namely, that the constancy of the spatial relations of the paths of discharge furnishes the physiological basis for a constancy of the values of sensations; and that a change in the spatial relations, conditioned by any of the factors enumerated above, is attended by a variation in the sensation value. In its most general formulation, then, the action theory states that every element of consciousness is co-ordinated with the cortical transition from excitation to discharge, in such manner that the quality of the sensation depends upon the spatial position of the path of excitation, the intensity of the sensation upon the strength of the excitation, the shading of value of the sensations upon the spatial position of the path of discharge, and the vividness of the sensation upon the strength of the discharge.

The detailed application of this theory to the special problems of psychology, is reserved for the second volume. A concluding chapter of the present volume, however, briefly indicates how it applies to attention, suggestion, hypnosis, apperception and abstraction. In a given complex that sensation which finds the conditions favorable for motor discharge, is grasped by the attention. That for which action is not ready, passes unnoticed or claims the attention only when the intensity of the excitation compels action. The attention can be distracted only by an excitation which leads to antagonistic action. In suggestion and hypnosis the suggested idea inhibits the opposite idea,—*i. e.*, the idea which incites opposite action—through the medium of the motor centres. The motor centres for certain groups of actions are so attuned that the innervation of the antagonistic movement becomes impossible; the antagonistic idea cannot, therefore, come to consciousness even when the appropriate sensory stimulus is applied. In the case of apperception there exists a peculiar molecular disposition of the motor centres as the result of previous practice. The present stimulus is therefore responded to by a richer and more complex reaction than would otherwise arise. This fuller motor reaction arouses a richer complex of sensory processes, and thus constitutes the psychophysical basis for the difference between apperception and perception. Abstraction is characterized by a general motor innervation. The concept is the idea corresponding to a motor reaction which is common to a group of objects.

Professor Münsterberg's psychology is an atomism of the most extreme and mechanical sort. Sensations are, he tells us, the ultimate products of present-day analysis, but it is by no means certain that the psychology of the future will not push the analysis farther, and decompose the sensations into *Urelemente*. These *Urelemente*, it may be conjectured, will be found to be each unique in kind; their reciprocal action and reaction may give rise to the various phenomena manifested by sensations—thus, *e. g.*, similarity and fusion are to be accounted for. In the present state of physical and physiological analysis, however, we have no elemental psychophysical processes with which to correlate the *Urelemente*. Since for that reason they have no noetic relation with the physical world, they are incapable of communication or explanation. All speculation regarding them must therefore remain, for the present at least, a theoretical luxury.

To summarize: Professor Münsterberg has assigned to psychology a definite place in the hierarchy of the sciences; he has marked off and characterized the subject matter with which psychology is to deal and shown how she is to deal with it; he has laid down a principle for the systematization of psychological knowledge; he has shown how the limitations of that knowledge are to be transcended, how a naturalistic psychology is to be recognized as but a one-sided representation of a reality of which an ethical idealism gives a more adequate account.

The point at which criticism can most effectively be directed against the system, is the assumption upon which is based the classification of the sciences. Here it is assumed that causality and teleology are not only antagonistic, but mutually exclusive categories. The science which has recourse to teleological explanation is held to be debarred, in consequence, from the employment of causal explanation and *vice versa*. This argument is also used, later on, as a weapon against Wundt's theory of apperception. From this assumption and the construction subsequently erected upon it, various paradoxical conclusions follow. Science deals not with a world of reality but with artifacts. The several sciences are not a corporate body but a congeries of discrete and independent disciplines. Their only common ground is the common core of primary experience from which they all radiate in divergent paths. Scientific co-operation, in any general sense of the term at least, is unmeaning. Physics and psychology seem to furnish an exception to this rule; here, however, the relation is not one of mutual reciprocity, but of arrogant dominance on the part of physics, and slavish dependence on the part of psychology. Psychology is denied the possibility of ever becoming an independent science; all her explanations are, at bottom, physiological and psychophysical. Moreover, psychology is divorced from the historical sciences; she belongs to the objectifying camp, they to the subjectifying. Since she is forbidden to interpret, or to draw upon history, it would appear that most writers upon social psychology, at least, have lived and labored in vain. Professor Münsterberg will find few psychologists to agree to this narrowing of subject-matter and method. His is, in the strictest sense, a structural psychology; he denies to functional psychology the right to exist.

There are likely to be protests from the historian as well. A dominant characteristic of modern historical science is its insistence upon the importance of tracing out the *causal nexus* which is held to run through sequences of events. Not only is this method to be abandoned, but no subjectifying science can consistently employ the concept of evolution in any causal sense. Rather than accept these conclusions the historian will raise the previous question and inquire into the logical justification of Professor Münsterberg's original assumption. Are causality and teleology essentially incompatible? Even if we limit the meaning of causality to include none but mechanico-quantitative relations, we can scarcely afford to dogmatize upon the question. In any case the questionable assumption that they are mutually exclusive makes an unstable foundation for a psychological system.

The synthesis between his philosophy and his psychology has not been accomplished in a manner that is satisfactory to the psychologist, at least. That it has been accomplished at all is due to the unreal character of the objects with which psychology is made to deal. The reality of the ethical self is secured by removing psychology from the world of reality and leaving her to content herself with fictitious mental processes.

A criticism of the action theory can scarcely be attempted until the

theory and its application have been presented in greater detail. The new hypothesis is in line with the motor tendency which has been forcing its way to the front in the literature of the past decade. Moreover, it permits an easy envisagement of the physiological processes which are held to be the substrate of mental phenomena. It is, however, based upon a purely hypothetical physiology; its ultimate triumph over other hypothesis of recent origin can only result from its ability to give a more adequate account of the facts of the mental life.

This book should be in the hands of every psychologist. The range of topics treated is wide, the argument is closely articulated and the mode of treatment is original in the extreme. Professor Münsterberg brings to bear upon his work a rare genius for keen and exhaustive analysis. His thorough grasp of details is no less remarkable than his power of systematic generalization. The questions which he discusses have in the main an epistemological bearing, and it is entirely disputable whether his conclusions will be accepted by any large number of his colleagues either in philosophy or in psychology. But quite apart from its more positive and direct contribution to psychological theory, the *Grundzüge* does a valuable service in its searching and systematic criticism of the foundations of the science. Even if not a single position advocated by the author be accepted, their very advocacy and refutation will tend to such a clearing up of ideas as is sorely needed in the science. J. W. BAIRD.

Cornell University.

Why the Mind has a Body, by C. A. STRONG. The Macmillan Co., 1903, pp. vii, 355.

The title of Professor Strong's book may be interpreted as a twofold promise; first, that the reader is to be given final reasons and not merely empirical formulas and, secondly, that the outcome is to be some form of idealistic doctrine. Both parts of the implicit promise are fulfilled; for, in solving the problem of the relation of consciousness to the physical world, the author rests his case on nothing less than the final nature of things and the final nature of things turns out to be mental. The application of this idealistic doctrine to the problem of psychophysical relationships may be anticipated in a few words.

Reality includes individual minds and other mental 'things-in-themselves.' Now it is inherent in the nature of reality that it should symbolize or represent itself, its symbols or representations being the phenomenal world of perception. Since 'brain-events,' together with their physical antecedents and consequents, belong to the symbolic or phenomenal world and 'mental-events' to the real world, it follows that bodily and mental processes can never meet on the same plane; the current terms 'parallelism' and 'interactionism' do not, therefore, properly represent the relation which they aim to express. The relation is rather one of symbol to thing symbolized, of appearance to reality. The metaphysical conception underlying this doctrine of relationship Professor Strong names Psychophysical Idealism.

The general argument of the book runs as follows. Three typical theories of the mutual relations of mind and body are in the field: the theory of automatism, the theory of interaction, and the theory of parallelism. Each theory—or better each group of theories, since each has various shades of meaning—has its positive arguments and against each strong objections, both formal and material, may be urged. The facts of experience are ambiguous; that is to say, they do not compel an acceptance of any one of the three theories to the exclusion of the other two. Interaction is not susceptible of proof because the causal efficacy of consciousness cannot be directly established; automatism is

illogical because it takes account of those facts only which are adapted to the support of a one-sided causal connection—from body to mind; parallelism, finally, which denies all causal connection between cerebral and mental processes, breaks upon certain facts of biological development that suggests an inherent 'survival value' in consciousness. Even were it possible to settle the elusive relation by appeal to empirical facts, the deeper question, 'why mind and body are related at all,' would remain. "Under these circumstances, the time seems to have arrived for the metaphysical enquiry announced at the beginning. . . . We have discussed the relation of mind and matter without knowing exactly what mind and matter are. We must now turn critically upon the conceptions that have answered our purpose thus far, and seek to make them adequate. It may be that an exact knowledge of what mind and matter are will help us to understand their relation." In carrying the question at issue to the higher court of philosophy, the author is careful to explain, first of all, why physical objects must be regarded as, at bottom, 'modifications of consciousness;' why consciousness—not a hypothetical 'soul' or 'subject,' but immediate experience—is a reality; and why the physical world and consciousness, as thus interpreted, give, together, a fragmentary universe which must be filled in by other, 'extra-mental,' realities; in brief, why 'phenomenalism,' as a philosophical creed, is inadequate.

Professor Strong now approaches the crucial point of his argument. To escape the failure of phenomenalism, he posits the existence of 'things-in-themselves'—"realities external to consciousness of which our perceptions are the symbols." After giving his attention to the historical arguments against 'things-in-themselves,' the author brings three 'positive proofs' of their existence; one proof from the necessity of a 'real' medium between mind and mind, another from the necessary conditions of consciousness, and a third from the origin of mind out of antecedent reality. But not alone the *necessity* for things-in-themselves is shown: we are given, also, a hint as to their *nature*." Since consciousness is "our only sample of what reality is like," and since minds must originate in a real thing of their own nature, we may conclude that the extra-mental reality known as things-in-themselves is itself mental.

Having completed the metaphysical deduction of reality and of its relation to the world of sense, the argument reverts to theories of psychophysical relations and considers them in their philosophical implications. In the practical application of his principles, the author has only to show that the thing-in-itself which is symbolizeed by the cerebral event is *identical with* the corresponding consciousness and his theory of psychophysical idealism is complete. Instead of the traditional brain-and-mind puzzle he has a single reality, accompanied by a symbolic expression, the physiological event. I say he 'has only to show'—as if the task were easy; but it really involves one of the subtlest bits of argumentation in the book.

To give anything like an adequate conception of the work before us would require much more than a running comment on the drift of the argument. At every step, special difficulties are met, counter-arguments are disposed of, rival theories are balanced; but still the logic of the book progresses. It is not easy to overestimate the task that the author has performed. For his fundamental conception, he does not claim originality; but he has done what students of the ultimate psychophysical problem are likely to consider of greater worth than a new theory of the universe: he has disentangled the facts of the case, weighed them, and brought them into immediate and logical relation to philosophical conceptions of the world. The result offers a striking

illustration of the fact—on the way, I suspect, to become a truism—that science and philosophy, however diverse their methods and their intentions, have vital interests in common. The book is, in a double sense, timely; a wide interest in the subject exists (witness the large number of monographs and articles in the current literature) and an authoritative and definitive statement of facts and theories was a pressing need.

The reviewer appends a few of the notes and comments that have accumulated in reading the book. (1) The theory of automatism receives, perhaps, both in the empirical and the metaphysical parts, more than its share of attention. It has always been an adventitious growth in psychology. It is, primarily, a makeshift of biologists and does not, in the writer's opinion, deserve to rank with the rival theories of interactionism and parallelism. (2) Professor Strong seems to overestimate the value to psychology of a metaphysical satisfaction of the psychophysical problem. Without for a moment underrating the author's accomplishment, it may be asserted that had an adequate solution been indefinitely postponed, such empirical theories as are now in the field would, nevertheless, be performing in the interim, good psychological service. '*Why* the mind has a body' turns out to be a philosophical problem; but that *some important relation* obtains between consciousness and bodily processes is a hard and well-seasoned matter of fact in science which in no way stands in need of philosophical sanction. If interaction works or parallelism works, the immediate requirements of science are satisfied. A sharp line of distinction must be drawn between what are, in strictness, *psychological* and *psychophysical conceptions* of the relation in question and *philosophical explanations* of the relation. The psychologist, as a psychologist, is never under the necessity of giving a philosophical justification for his working principle—whether it be of concomitance or of causal interaction. I am not sure that he would be wise—so long as his principle worked satisfactorily—to abandon his position were the universe at large to convict him of stubborn insistence on a metaphysical impossibility. I am not sure he might yield for the sake of 'vital common interests!' But the point is that however 'unreal' the world of sense, psychology, together with natural science, *must* descend into that world six days out of the week and *must* take account of it. If brain-events are representations of things-in-themselves they are also—what is much more important to the psychologist—cerebral functions which are bound up with mental processes. In the work-a-day world of science, parallelism helps because it recognizes this fact. It may *simply* recognize it—not even denying interaction—and still be parallelism. Thus it comes about that however strong our allegiance may be to psychophysical idealism, we must—just so long as we go down into a phenomenal world to work among 'physical shadows' and 'symbols'—employ terms adequate to the behavior and to the interrelations of 'phenomenal' things and events. (3) Psychophysical idealism, which peoples the real world with conscious things-in-themselves, is curiously like certain 'representation' theories of mind, read backward. The common property of individual minds and other things-in-themselves seems to be the capacity to symbolize, to create for themselves phenomenal 'doubles.' But is it of the essential nature of consciousness to be symbolic? Or is it only of consciousness at a given 'intellectual' level of development? Although Professor Strong attempts to make his type of idealism the idealism of 'feeling,' I am not sure but that it is, really, the idealism of 'perception,' whose "fundamental maxim is '*esse-percipi*.'" Were we to take "as our sample the consciousness of an earthworm or a polyp"

—as the author allows us to do—it is possible that things-in-themselves would wear a different aspect. (4) The theory of extra-mental realities proves to be superfluous for the immediate satisfaction of parallelistic doctrine; for the *individual mind* is the only real side of brain-events and brain events are the only fragments of the physical world that parallelism is concerned with. All other realities remain as a kind of adhesive medium whose difficult function it is to prevent a pluralism of individual minds. (5) If the reviewer has not missed the author's meaning, the theory of psychophysical idealism parallels reality—in so far as reality is individual mind—with two, not one, phenomenal 'symbols.' For the physical object, since it is a 'modification of consciousness,' must be a symbolic, phenomenal modification of that consciousness; but that same consciousness is already represented symbolically by its brain-event. Another difficulty arises: the physical object represents not only consciousness but also the real thing-in-itself for which it appears. We have, then, one reality (consciousness) with two symbols and one symbol (physical object) with two realities. The obvious way out is solipsism; *i. e.*, the thing-in-itself is identical with the individual consciousness. Even this solution is not highly satisfactory, for it leaves us with the paradox: reality as individual consciousness is paralleled by object of perception, as thing-in-itself by brain-event—whereas it ought to come out just the other way round. Then, too, solipsism brings back the old difficulty of pluralism. (6) In the latter discussion of parallelistic theories, Fechner's name is conspicuous for its absence,—though his historical importance is acknowledged in the preface,—and Wundt's theory of 'actuality' should have had at least a paragraph. This criticism might, indeed, be made more general; for references to the current literature are almost entirely wanting. The reviewer would consider this omission serious where the book is to be placed in the hands of students. The author has recently (Psych. Rev. XI, No. 1, p. 67) supplied a partial list of references.

Cornell University. I. MADISON BENTLEY.

Die reproducierte Vorstellung beim Wiedererkennen und beim Vergleichen. E. A. McC. GAMBLE AND M. W. CALKINS. *Zeitschrift für Psych. u. Physiol. der Sinnesorgane*, XXXII, pp. 177-199; and XXXIII, pp. 161-170.

This paper states the results of an experimental investigation of the theory of Lehmann, that recognition consists in the image, or series of images, associated with the experience which is felt to be familiar. The introduction contrasts the doctrine of Lehmann (1) with the theories by which recognition is, or includes, a complex of affectively toned organic sensations, and (2) with the doctrine that the essential feature of recognition is an unsensational and unaffective content of consciousness—a certain distinctive "feeling of familiarity."

The experiments fall into two groups, each suggested by tests made by Lehmann himself. The first set of experiments furnishes data for a statistical analysis of recognition. The subject was given a series of odors in absolutely uniform bottles, and was required (1) to write down after smelling each odor, the associated images as nearly in their order as possible, (2) to mark with a dash any pause in the train of images, (3) to state in writing whether the smell was familiar or unfamiliar, and (4) to set down its name if known. The average number of odors used was forty-six. The total number of subjects was twenty-four. Of these subjects, twenty-one were undergraduate students and three were teachers of psychology. No subject understood the purpose of the experiment. In stating the results, the

smelling of each odor by each subject is counted as one "case." The total number of cases is 1,106.

The results furnish three arguments against the Lehmann theory. First, as in Lehmann's own results, there was a small percentage of the total number of cases (.9% for the practiced and 4.7% for the unpracticed observers), in which recognition appeared to occur without supplementary associations. It seems unlikely that recognition consists essentially of experiences too fleeting or too obscure to be detected introspectively. Second, in 6.2% of the total number of cases, smells were pronounced unfamiliar despite the fact that associations were recorded which were "correct" in the sense of being clearly explicable by former experiences of the same or of similar smells. For the verification of this most important point, a separate count was made of the cases in which olfactory associations (smell-names, not necessarily smell-images) occurred. The total number of such cases was 700. In 97 of these cases the smells were pronounced unfamiliar. In 62.9% of these 97 cases, the olfactory associations included or consisted of the names of smells which were similar strictly (according to Zwaardemaker's classification) as odors and not merely in affective value. Third, in 23.9% of the 869 cases in which the odors were pronounced familiar, the supplementary associations are expressly indicated as coming later than the feeling of familiarity.

The same set of results furnish data for two incidental conclusions. First, the time-notes of the observers showed that in many cases neither the feeling of familiarity nor the feeling of unfamiliarity as understood by them supervened directly upon the sensing of the stimulus. In the interval consciousness was filled simply with the sensation. Thus, the feeling of unfamiliarity seems to be a positive experience and not merely a negation of familiarity feeling. Second, out of 233 cases in which the odor was correctly named, in 76.4% the name given was the first association in a series, whereas in only 9% was it the last association. These figures bring out the high suggestive value of the name; they do not tend to show that the name caps and completes recognition by closing the association series.

Furthermore, it is worthy of incidental notice, that the records contain a few spontaneous references to the "effort" to recognize or to the "relief" of recognition. The fact that these remarks were unsolicited lends support to the view that organic sensations play an important part in recognition. Moreover, there is one statement in the records which might possibly be interpreted as a reference to a non-sensational and non-affective consciousness of familiarity.

Aside from these references, the outcome of the experiments is purely negative and may be stated thus: The recognition consciousness is not constituted by associated images whatever it may actually consist in and however generally such associations may be present in it.

The second group of experiments consisted in tests of qualitative discrimination for named stimuli as compared with unnamed stimuli of the same character. Both colors and smells were used. The colors, in the form of blue and purple liquids and of (Marbe's) blue and gray papers were alike in hue but were graduated in brightness with nine colors to a series. The odors consisted of groups of seven piney essential oils and seven artificial perfumes. Before the discrimination experiments were made, a set of names (scale-names, such as "Lightest" and "Very light," for the colors, and individual names, such as "Syringa" and "Rosemary," for the smells) were impressed upon the observer for one or the other of the two comparable sets of stimuli. As indicated above, the object of the experiment was to ascertain whether verbal associations attached to the one set of stimuli would

make discrimination more accurate for it than for the other. Each color was compared only with its own next neighbor in the series whereas each odor was compared with every other odor in the same group. In a certain proportion of the comparisons, the same color or odor was repeated. The interval between the stimuli compared was one minute *minus* the seconds of the first exposure-time, namely, ten seconds for the odors, five seconds for the colored papers and two seconds for the colored liquids. The subjects were all under-graduates, three or four in number for each two sets of comparable stimuli. Each observer made at least one hundred comparisons within each set of stimuli.

A comparison of the number of errors for the named and for the unnamed stimuli shows that a scheme of names was of slight assistance to three-fifths of our subjects in qualitative discrimination, but that the advantage was trifling, not a gain of 5% of right cases for the named series. An examination, however, of the direction of errors so appertained shows that at least, in the case of the colors the name-images aided only in discrimination proper, and actually increased the number of failures to identify. When the stimulus was repeated the percentage of wrong cases in the named series exceeded by ten the percentage in the unnamed series. Thus, it would appear that in so far as recognition is equivalent to the consciousness of sameness, associations artificially provided in the form of verbal tags tend rather to inhibit than to facilitate its occurrence. The result, therefore, of the investigation as a whole is to discount the value of supplementary associations both in recognition and in comparison.

ELEANOR A. MCC. GAMBLE.

On the Validity of the Ergograph as a Measurer of Work Capacity. A Contribution to Practice and Learning, by T. L. BOLTON and ELEANORA T. MILLER. Nebraska University Studies, Lincoln, 1904, pp. 79-128.

This article gives the results of an experimental study with the ergograph, with the object of determining the value of ergograph records as an accurate measure of work capacity. A detailed analysis of the various factors that enter in determining the ergograph results furnishes the basis for such determination. Thus directed, the study gives results of psychological interest beyond that of merely determining the value of an apparatus. Some general observations on the factors in muscular training, and 'physiological considerations' are first briefly reviewed. Their object then becomes that of a scientific study of these supposed factors. The authors were the two subjects in the experiment, which extended over three months. A procedure similar to the usual in ergograph work was followed. "The ergograph used was a modified form of the pattern designed by Dr. Hoch in Kraepelin's laboratory." A plate, with description, gives the details of the apparatus. Introspective results supplement and interpret the eight full tables given. Four elements in practice gain are first pointed out and described. *First*, inurement, 'a process of hardening and toughening of the skin where it comes in contact with the apparatus, and of habituating the muscles to the strains which the unusual effort imposes.' The severe strain the authors regard as causing 'small leisons of the tissues through the rubbing and twisting of muscular and tendonal fibres about one another which are followed by local inflammations.' This inurement appears rapidly, and is completed before any of the other effects of practice. It is also the first to disappear when work ceases. *Second*, perfection in the co-ordination of movements. At first there are various accessory and useless movements, muscles in the other fingers of the hand, and various other muscles over the whole body being involved

in the strain of maximum effort. These drop out later, and a condition is finally attained in which 'the actual exhaustion point is reached without visible physical or mental signs of fatigue, and it seems to avail nothing to put effort into it.' *Third*, increase in the ability to make the movements rhythmically. Between the metronome beats each part of the movement, together with other stimuli from the apparatus, must be the stimulus for the next part, separated by a time interval that is practically equal to the full reflex time of such act. The whole must become 'a series of reflex actions joined together in a serial order by habit.' *Fourth*, endurance. This is interpreted as an 'increase in the power of the nerve centre to excite a muscle to perform a certain work a greater number of times than it could before the exercise.' Of the four elements in practice gain enumerated, this one is acquired more slowly. The working of these four factors, and their inter-relations in affecting the work capacity are then further traced out in the results. After three rest periods of six days each the work capacity begins each time at a point above that at which it stood when the rest period began. This they attribute to the last factor, accounting for it by the supposition that 'the nerve centres and muscles were in a state of incipient exhaustion, and that during the rest period they built themselves up to the highest level of metabolic change for which they had been prepared by the exercise.' A very large vicarious practice effect is found, when one hand is given a rest period while work with the other continues, and this in spite of the loss of inurement during the rest period for the unused hand. This vicarious practice they regard as mostly in the direction of co-ordination and rhythm. The records for the right and left hands also show certain differences in the progress of practice gain, indicating that the different elements in practice gain may enter in different relations for different muscles. 'Different muscles in the same person seem to show idiosyncracies in the way they work. What one accomplishes in the way of skill another makes up through endurance.' From all these relations it happens that the hand that shows the greater practice gain at first may not do so later, and the order of the two hands may alternate more than once. Again, lack of inurement at first keeps the record down. As this lack diminishes the practice gain will be great, and later it will be less, due to a change again in the relation of the factors that enter. In a daily series of several contractions to exhaustion with one minute pauses between, the recuperative value of the pauses may be different for the two hands; it changes with the degree of practice attained, as does also the relative recuperative value of the successive minute pauses. Hence, in regard to the value of the ergograph as a means of measuring work capacity, the authors conclude that 'ergograph records change relatively in the course of a long series and thus the first records in a series are invalidated, for maximum performances furnish a more reliable measure of work capacity. That since exercise induces a condition within the muscles themselves which reduces their capacity for work, ergograph records have slight validity until inurement has become thorough and co-ordination complete. That the ergograph is quite unadapted to the obtaining of exact statistics upon a large number of individuals. That records taken upon unpracticed subjects, both before and after operations, whose influences are thought to affect muscular power, are without the slightest claim to trustworthiness.'

F. KUHLMANN.

Clark University.

The Principles of Logic. PROFESSOR H. AUSTIN AIKINS, Western Reserve University. New York, Holt & Co. pp. x+489.

In view of the present wealth of text-books on Logic a new book on

this subject needs something to justify its existence. Professor Aikins's book has this justification. In his treatment of induction he has included several valuable chapters which do not appear in the ordinary text-book and he has endeavored to present deductive logic in a new way. He attempts to treat it from the objective standpoint. It is to be, not a science of thought nor a science of the proper arrangement of words but a science of things as they are dealt with in thought. It "points out the laws of things which all thought should respect," it "deals with the mental implications of the relations of things."

Instead of relations simply of inclusion and exclusion he makes use of five fundamental relations: those of individual identity, subject and attribute, causal or dynamic, non-dynamic and noetic, besides combinations of these. Conversion receives a broad treatment but the most important changes have to do with the syllogism. The traditional rules are thrown overboard and an attempt is made to find the underlying principle of each of the first three figures—the fourth being eliminated as involving no new principles. For the first figure the principle is: What is said to be true of every member of a group (or every object which possesses a given relation) is said about each one of them even though each is not separately thought of when the statement is made. Two cautions are added: 1. "A relation can belong to some members of a group without belonging to all the members, to any given member, or to any one of a given group of members," and 2, "To say that something is true of certain objects does not imply that it is false of others." Similarly of figures two and three, though the matter is more complicated in those cases.

This mode of treatment is certainly very attractive; it seems much less arbitrary; we may agree with Professor Aikins that it is more philosophical, at least in its aim, than is the traditional treatment, but the claim that it is better pedagogically is more than doubtful. The clearness and definiteness of the traditional treatment has a pedagogical value that is lacking here, particularly in the case of the second and third figures. The beginner would have more difficulty in applying the somewhat complicated system of principles and cautions than in using the old rules. For the advanced student Professor Aikins's method is certainly a good one and should deduction be taught in its proper place, after induction, his method might be applied to better advantage.

Particularly noteworthy in the portion of the book devoted to induction are the chapters on statistics, averages and testimony. The last is usually omitted altogether and the first two seldom receive more than a perfunctory discussion. Unfortunately the time usually allotted to logic is too brief to permit the use of the entire book.

A more serious objection to the work as a text-book is the amount of controversial matter it contains. It would have been better if the author had stated his positions dogmatically here and justified them in some work not intended for an elementary text-book.

Many points besides those noted should be discussed, if there were space, but it must be admitted that the author's aim is most praiseworthy and that, whatever the faults of his book, he certainly does make logic a live subject.

ADAM LEROY JONES.

Columbia University.

Die Perioden des menschlichen Organismus in ihrer psychologischen und biologischen Bedeutung, von DR. HARMANN SWOBODA. Franz Deuticke, Leipzig, 1904. pp. 135.

This author scores current psychology, speculative and experimental, which he accuses of absolute fruitlessness. The laboratory gives us only a little more exact expression of what everybody knew before.

It has isolated a topic in which the public has a profound interest and given it a terminology which none but experts can understand. Recent as it is, its pathway is already strewn with dead books. It has desouled psychology. He insists that the only way of salvation is the out-of-door natural history standpoint and, in this work which is devoted to the psychological and biological significance of rhythm in the human organism, he collects many facts from normal and abnormal life that show a monthly periodicity. Reminiscence, he thinks, shows this type and he collects various cases. His work is evidently inspired by fliesses noteworthy study of pathological phenomena which took its point of departure from the menstrual rhythm and its relations to the nasal organ. There are various other periods that Swoboda thinks he has established. Periodicity is a spontaneous tendency to repetition and certain *freisteigende* impressions in waking hours, in twilight reveries, in dreams, in the creativeness of artists and writers, in power to recollect, in the sexual life, in circular insanity, in conversions, conceptions, epileptic tendencies, moods in people subject to them, whom he thinks a class by themselves, all have a monthly rhythm. This is not very apparent in the relational life of association which is dependent upon the environment, but if we only had a method of measuring the spontaneities of mentation, he believes that his thesis would be abundantly demonstrated. All that can be said of it now is that it is an interesting and suggestive but by no means demonstrated doctrine which his book represents.

Proceedings of the Third Meeting of the American Philosophical Association, Princeton Univ., Dec. 29, 30, and 31, 1903, with the address of the President, The Eternal and the Practical, by PROFESSOR JOSIAH ROYCE. New Era Printing Co., Lancaster, Pa., 1904. pp. 142.

This pamphlet gives very brief extracts of many papers which must have made a very memorable meeting, and prints the address of President Royce on The Eternal and the Practical in full. After reading and rereading the abstracts it is very difficulty to form any very clear idea of what many of them attempted to say. For instance, the paper of Spaulding on The Establishment of Association in Hermit Crabs is absolutely unintelligible although his topic is plain. The few lines on Sheldon's paper on Intensity convey no idea that the writer of this note is able to grasp. McAllister's experiments, Tuft's paper on Moral Sense in British Thought, and to a somewhat less extent, the contributions of Sewall, Campbell, Montgomery, Hammond and Creighton, no doubt in themselves luminous and valuable papers, cannot possibly have any lucidity to those who are compelled to depend upon these abstracts for their knowledge.

Einführung in die Philosophie der Reinen Erfahrung, von JOSEPH PETZOLDT. Vol. II. B. G. Teubner, Leipzig, 1904. pp. 341.

The most essential feature of this book is the attempt to carry through the thought that man is not a durable type but an organism in a very active stage of development. But the permanent condition of men, the author holds, can be developed in its main features and on its formal side, and thus only we get the basis of ethics, æsthetics, etc. Regularity consists in the sequence of development and the tendencies to stability are psychic. The question of a goal of this development and of its ethical, æsthetical and logical characteristics constitutes the most interesting part of this book. It seems to the writer of this note to rest on two contradictory assumptions. On the one hand it makes concessions to evolution and gives it a large sphere, but on the

other hand it assumes that at the present stage of things we can predict finality, and it is on this that all his sequences are based.

A Journey to Lhasa and Central Tibet, by SARAT CHANDRA DAS, C. I. E. E. P. Dutton & Co., New York, 1902. pp. 285.

This learned and Christianized Hindu, Chandra Das, born in 1849, became an engineer. One of his fellow students was a lama from Tibet. In 1879, and again in 1884, Das visited Tibet, spending some time at Lhasa and meeting the grand lama. He spoke their language and wore the dress of the country and accomplished an enormous amount of literary work in the way of translations and rendered great service to geography. For political reasons the story of his travels is only just published. He underwent enormous hardships but was privileged to see very much that no English writer has ever witnessed. He gives us interesting perspective drawings, and also a few photographs of the lama, and some of the great Buddhist temples in that country.

Ethnic Factors in South America, by TALCOTT WILLIAMS. The Annals of the American Academy of Political and Social Science, July, 1903. pp. 25-31.

These leaflets are noteworthy for the general statistics which they contain. In South America, we are told, the population is to-day from half to three-quarters Indian and the white population not over one-fifth. This latter small Spanish speaking people, with odds of five or six to one, is endeavoring, in a region still containing a free and aboriginal population, or its descendants mixed with negro slaves and half-breeds, to maintain and advance the civilization of the Latin races of South Europe. In South as in North America ethnic differences are not sufficiently borne in mind. South America with its total population of forty million people, of which hardly eight million are pure whites, seems destined to maintain this disproportion.

A Practical Treatise on Nervous Diseases, by F. SAVARY PEARCE. D. Appleton & Co., New York, 1904. pp. 401.

This text book is intended for students and general practitioners. Doubtful points in neurology are curtailed and the practical aspects held chiefly in view. The first forty-seven pages are given to general anatomy and physiology of the nervous system. Then follow methods of examination, prevention of disease, symptomatic disorders, diseases of the cranial, peripheral, spinal nerves, of the brain membranes, local brain diseases, those of the cord, functional, vasomotor, trophic, toxæmic, paretic, troubles, with an appendix on the disorders of sleep. The book is illustrated by ninety-one diagrams and illustrations many of which are pictures of special cases from the author's practice.

Malay Magic, by WALTER WILLIAM SKEAT. Macmillan & Co., Ltd., New York, 1900. pp. 685.

The contents of this book is divided conveniently into ideas concerning nature, man, his origin, soul, place in the universe, the relations with the supernatural world, the Malay pantheon, magic rites connected with air, earth, water and fire, and as affecting the life of man, including birth, adolescence, betrothal, marriage, funerals, medicine, dances, games, theatre, war, weapons, divination and the black art. A number of interesting illustrations are scattered through the book.

Le monde Polynésien, par HENRI MAGER. Schleicher Frères, Paris, 1902. pp. 250.

The origin of the Polynesian Islands is first treated and then the

supposed origin of the people. Then in natural order comes the discoveries, annexations, colonization. Comparatively little is said about the people themselves.

Kulturprobleme der Gegenwart. Bd. IV. Rasse und Milieu, von HEINRICH DRIESMANS. Johannes Räde, Berlin W. 15. 1902. pp. 235.

This work is the fourth volume of a series edited by Leo Burg and entitled Culture Problems of the Present. He first discusses the primitive man and his environment, trying to develop the relations between them. He then describes the origin of caste, migrations, the historical races in Europe, evaluates the Mongol element, discusses the effect of mixture of blood and cultures and of natural selection. Perhaps the most interesting parts are those which treat of France, Spain, Russia and Germany.

Aboriginal American Basketry: Studies in a Textile Art without Machinery, by OTIS TUFTON MASON. Report of the United States National Museum for 1902. pp. 171-548. Government Printing Office, Washington, D. C., 1904.

No one can even look at the 248 full page cuts, many of them colored, which this book contains, without being struck with amazement at the variety and subtlety of this art among our Indians. The whole subject could have fallen to no more competent hands than those of Professor Mason, who has for years studied this subject. His own text is between three and four hundred pages, and altogether this volume will be indispensable for everybody interested in the subject.

Archiv für Rassen- und Gesellschafts-Biologie einschliesslich Rassen-Gesellschafts-Hygiene. Herausgegeben von Dr. med. ALFRED PLOETZ. 1. Jahrgang. 1. Heft. Januar, 1904. Berlin, 1904. pp. 158.

This extremely valuable new Archiv contains eight interesting original articles and many reviews all of which are carefully made and which promise good things in store. Six heften are promised per year at twenty marks. The names of the co-operating editors fill two pages and are several score in number, the only Americans being Jessen of Harvard and Hass of Bryn Mawr. Among these we observe none from either France, England or Italy.

NOTE.

Through the inadvertent omission of a foot-note to my article "Attention Waves and Fatigue" in the Commemorative number (July-October, 1903), I am made to say too positively that Professor Kulpe is of the evening type. Professor Külpe's own statement concerning his working habits is: "I have never made exact measurements as to my type, but my experience would indicate that I am neither a morning or an evening worker. Earlier (in my student and early docent days) I was accustomed to prefer the mornings for work in summer and the evenings in winter, and can still work either period at will. I work more effectively physically in the evening."

W. B. PILLSBURY.

THE AMERICAN

JOURNAL OF PSYCHOLOGY

Founded by G. STANLEY HALL in 1887.

VOL. XV. JULY, 1904. No. 3.

A PRELIMINARY STUDY OF THE PSYCHOLOGY OF THE ENGLISH SPARROW.

(From the Psychological Laboratory of Indiana University.)

By JAMES P. PORTER,

Late Instructor in Psychology, Indiana University.

The present study was begun in the autumn of 1901 at the suggestion of Professor Ernest H. Lindley.[1] Since that time the study has come to include a comparative study of the English Sparrow with other birds, especially closely related species —this comparative study to be both psychological and neurological. Although something has been done in the study of other species and on the brain of the English Sparrow, the present paper will deal almost exclusively with the psychology of this bird.

There are many reasons for making the present study. First, the mental life of mature birds has not yet been very thoroughly investigated. The work of Professors Morgan, Mills, Thorndike and others with young birds has brought out some facts that are also half true for adult birds, and Hachet-Souplet, in his training of "pigeons, some of the Gallinæ, sparrows, etc.," has shown how easily and rapidly associations may be established and habits of reaction formed.[2] But no one has made a

[1] I am also indebted to Dr. Lindley for help throughout in devising of experiments and in the interpretation of results; to Professor J. A. Bergström for his sympathy and helpful suggestions. Also to Professor E. C. Sanford for helpful advice in the final preparation of the manuscript, and to Mr. Louis N. Wilson for his kind help in securing the necessary references.

[2] Hachet-Souplet: Examen psychologique des Animaux, p. 37; also Le Dressage des Animaux, pp. 192-194.

study of the psychical life of mature birds which shows the full range of their ability to profit by experience, to discriminate, to inhibit useless actions and reinforce useful ones.

Secondly, something should be done to determine whether the English Sparrow is more intelligent than other birds which he has driven out; to explain to what it is due that he has made such a signal success in adapting himself to the new conditions in the forty years which have elapsed since the first English Sparrows were imported into the United States.

It is surprising how rapidly this bird came into prominence in an economic and scientific way. In 1879 Dr. Coues, in an article which had for its main motive the prevention of the further spread of this bird into the Western Territories, gave a bibliography of 210 different articles on the sparrow written since 1867. This great interest was also attested by the fact that Dr. C. Hart Merriam made it the subject of the first Bulletin issued by the Division of Mammalogy and Entomology of the Department of Agriculture, under the title of "The English Sparrow in its Relation to Agriculture."[1] This large and splendid monograph was based on answers received to a set of questions sent out from Washington and on scientific investigations wherever possible. The great majority of persons answering the questions agreed that the English Sparrow drives out most other birds, often those much larger than himself, and that he has few successful enemies; even cats succeed in killing very few of either the old or the young. Recent observations go to show that the English Sparrow exhibits a relatively wide range of adaptability in the choice of nesting places. According to a very competent observer they now use the holes in banks in the West made by Cliff Swallows, and I have seen a male sparrow do his best to persuade a female that a hole in an electric-light pole was the very best place for a nest. They also apparently live very peaceably with Pigeons in the houses of the latter and another observer has reported to me that he observed a fight between a Red-headed Woodpecker and a Sparrow in which the former was driven away even after he had gone down into what may very well have been his nest and pulled the sparrow out by the feathers of the head.

Mr. Will T. Hill[2] and Mr. Otto Widman,[3] both of whose articles Dr. Merriam gives in full, have something to say of the English Sparrow's intelligence and would most fully, I think,

[1] Prepared under the direction of Dr. C. Hart Merriam by Walter B. Barrows.

[2] Will T. Hill: American Field, Jan. 14, 1888.

[3] Otto Widman: History of the House Sparrow, *Passer Domesticus*, and the European Tree Sparrow, *Passer Montanus*, at St. Louis, Mo., pp. 191-194, of Bulletin No. 1 of U. S. Dept. of Agriculture cited above.

agree with Brehm who writes as follows: "It is characteristic of the Sparrow that wherever he goes he lives in the most intimate relations with man. . . . Well gifted mentally he has acquired little by little a knowledge of man and his customs. Everywhere and under all circumstances he controls his actions in obtaining his food in the most exact manner. Accordingly he is an entirely different bird in the city from what he is in the country, where he is careless, trustful, and obtrusive. But where he must suffer the consequences he is cautious, sly, and always cunning. Nothing that may be useful or harmful to him escapes his sharp glance. His rules of action based on his own experience last him from year to year and this may be used to recognize the old from the young as the wise from the foolish. As with man he lives also with other animals in a more or less friendly relation, trusting the dog, forcing himself on the horse, warning his fellows and other birds of the approach of the cat, stealing from the chickens, . . ."[1]

And Mr. Hill, of Indianapolis, Indiana, who has kindly furnished me with most of my birds and who has made it his sole business since 1887 to catch the English Sparrow for trap-shooting, says in a letter of recent date, "The English Sparrow has an intelligence peculiar to itself. Being only where man and man's works are and by familiarity it often displays wonderful judgment in that which is harmful to it and that which is not. I think it is the most intelligent of all small birds. Almost any bird can be caught by simple methods, but the only successful way to catch sparrows is to cause it to act impulsively before it has time to think twice. 'Intelligent' hardly tells it, he 's too much for me. I once had 63 varieties of native birds in captivity at one time."

"The history of the sparrow begins with the history of man, and there is every reason to believe that this bird was well known to the people of whom we have no written history; certainly frequent mention of it is made in the histories of the earliest civilizations of Europe. The sparrow is repeatedly mentioned by Aristotle and by almost every European writer on natural history who succeeded him."[2] It would be strange if this bird which has lived in such close proximity to man for such a period of time, and has made man, in spite of himself, feed and shelter him, did not show something of the same mental superiority which, for the same reason, is claimed for the dog, rat, horse, and some squirrels.[3]

This very brief statement will suffice to show what was in

---

[1] Brehm: Theirleben, Zweite Abtheilung. Vögel. Zweiter Band. pp. 314-315.

[2] Merriam & Barrows: *op. cit.*, p. 301.

[3] Wesley Mills: Animal Intelligence, p. 74.

mind in beginning the present study, and I hope to be able later, in connection with the comparative study proper, to describe more fully the English Sparrow as he is in real life.

Observations and Experiments on Free Sparrows: Method of Approaching Food.

My first step was to study the way in which English Sparrows approach their food. Dr. Lindley had noted many times that they first alighted some distance away from it and approached gradually by short hops. On observing I noted the same thing. To obtain some quantitative expression for this, I laid off in a back yard a plot twenty feet square, and divided it into one hundred smaller squares, two feet each way. In the centre was marked off a square one foot each way. In this I placed the food. The strips of cloth used to mark off the squares were of a brown color, as nearly as possible the same as that of the soil and dead grass. My place of hiding was some fifteen feet away. They were frequently disturbed, but returned readily and I was enabled to repeat my observations as long as I wished. The food used was a mixture, half-and-half of cracked wheat and corn. I first put out food on November 14 at 6.30 A.M. All the observations were made about this time on following days. The birds did not find the food until the fourth day when I made it more conspicuous by placing with it some soaked bread. Then it was only a few minutes until they began to come. I held in my hand a reduced plot (⅛ of an inch to the foot) and placed a dot to mark the place of alighting of each sparrow. I watched for fifteen minutes each morning. The number of different birds was rather difficult to obtain, but ranged from three to fifteen. The number increased as the experiment progressed, except for the last two or three days. By measuring the distance of each dot from the centre on my reduced plot, getting the average and making the reduction, the following table was obtained:

Date.	No. of Visits to Food.	Average Distance (in inches).
Nov. 17	40	46.5
" 18	23	38.2
" 19	60	34.1
" 20	53	34
" 21	62	21
" 22	46	26.3
" 25	48	22.9
" 26	56	23
" 27	60	20.9
" 28	103	16.4

Date.	No. of Visits to Food.	Average Distance (in inches)
Nov. 29	60	23.7
" 30	85	13.8
Dec. 1	7	13
" 2	25	24.7
" 3	27	21.7

These results show a considerable reduction in the distance at which the birds alight from the food; and yet many of the birds never came to alight directly on the food. My observation since, both in the laboratory and outside, point to the same method of approach. The reduction, however, is somewhat greater than the table shows for the food was spread out over the space in the centre and after becoming accustomed to the place they came in such great numbers and kept changing so rapidly that I could not put down dots fast enough.

I am convinced from the wariness which they showed in so many ways in this experiment, and in my work with them in captivity, that this method of approaching their food is fairly well established, and like the "agoraphobia" of some animals perhaps does not disappear in a short time even when the necessity for it is no longer present.

This experiment showed also the readiness with which English Sparrows learn to associate. They learned to come to the trees and grape-arbor near by as soon as I began to turn a chain-pump, which I did the first few times before putting the food out. They also learned to come in answer to my whistle. On the other hand their wariness was little affected. Once when I had to remove a long pole which leaned over their plot they did not come for quite a while. Why they ceased to come toward the last I do not know unless the stormy weather and snow which came at this time had something to do with it.

Method of Experimentation and Special Precautions.

The general method used was the one common in comparative psychology of requiring the hungry animal to overcome some simple difficulty in order to obtain food. In all the tests an attempt was made not only to get the time measure of the rate and the methods of learning employed, but also to get the number and character of efforts made in each trial. Since the sorts of efforts fell into fairly separate and distinct classes, the attempt has been in a measure successful.

The work on the English Sparrow took much more time than had been expected because of the difficulty of keeping the birds in good condition and yet having them hungry when my time would allow me to experiment with them. Animals generally spend a large part of their waking lives in seeking and eating

food, and since, in a general way, it is accepted that the vital processes in birds are very rapid, it was doubly necessary to guard against extreme hunger. To this end I hardly ever used a condition of hunger greater than would be caused by an over-night fast. Food was usually taken away at eight A. M. and tests were made an hour later, so that except when new experiments were being attempted they were rarely without food for more than two or three hours.

The food given them was a mixture of cracked wheat and corn, soaked bread, and recently bird seed of several different kinds. This, as will be seen from the government reports, is largely the kind of food which these birds eat naturally. They have been well supplied with sand and gravel. At first they were kept in a small basement room, poorly heated and ventilated, where the direct sunlight hardly ever reached them. But recently, and while making the major part of the experiments, they have had an attic room where they got the morning sun and where there was plenty of heat and fresh air. Usually, unless for control tests, the birds had been kept in a small cage for several days or weeks before they were put in the large cage (eight by four by seven feet in size), in which all the experiments were made. They had become pretty well accustomed to their surroundings before they were subjected to any tests.

The apparatus used in the study of the sparrow's methods of learning was a small box with one end and side covered with one-fourth inch wire netting. See Fig. 1. A hole three inches square was cut in the middle of the side covered with wire and a wire door made for this. The door was made heavier by doubling the wire and weighted at the top and the right hand corner, the hinges being on the left. The box was tilted forward slightly so that the door would swing open when the latch, which consisted of a thin strip of brass, had been lifted out of the catch. This catch was at first one-fourth of an inch in height. Food was placed in this small box and this set down in the centre of the large cage. Care was taken to habituate the birds to this small box by leaving the door open and allowing them to feed out of it for a few times. In fact, I found that when the box was put in with the door closed, the bird having never seen the box before, it did not succeed in opening the door in a reasonable length of time. But by allowing the bird to learn where the door is and then closing it, he, of course, had a more limited territory in which to work and soon hit upon the right thing.

In the tests the birds were free to enter the small testing box or not as they chose; there was no compulsion. The same was true of the experiments with the maze to be described

presently. This, I think is an important precaution with the English Sparrow and, in fact, with all birds. It is natural that they should feel confinement in small quarters, and the

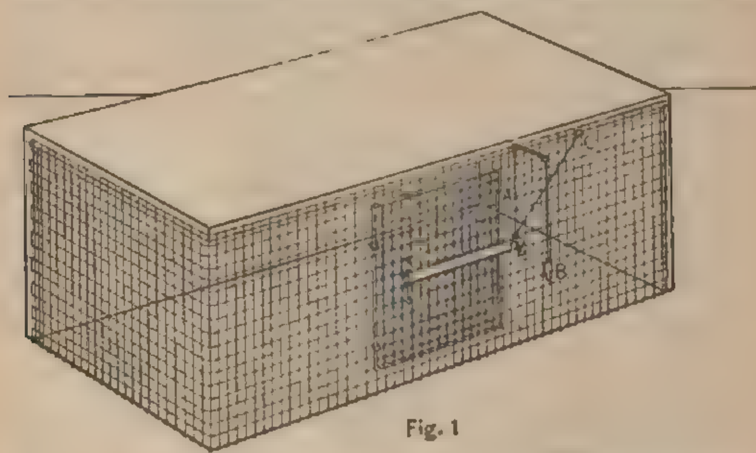


Fig. 1

Sparrow "while adapting himself readily to confinement never becomes reconciled to it." Morgan's exhortation to avoid cramped quarters and extreme hunger in experimenting with animals would seem to be especially applicable here.[1]

For the first series of experiments with the small box described above, a string was fastened to the latch, passed directly upward to a ring at the upper edge of the box, thence out along the wire arm, through a ring on the end of this arm and down some two and a half inches from the side of the cage and a little to the right of the door. See Fig. 1, A.B. A loop was tied in this string at the level of the bird's head. This string was used by the birds in the first series of the experiments only. As there was nothing to prevent them from pecking the latch this was done and this latter method was one used oftener than any other as will be seen in the description of each of the series to be given later.

In later experiments I have attached the string in another way, running it from the latch to a nail driven into the upper edge of the box. See Fig. 1 C. When the bird climbs over the side of the cage he pushes in the string and lifts the latch at its lower end. The door swings open as soon as the bird releases the string. One bird learned to push this string in with his head and later with his bill. The last bird, a female, learned to open the door by pushing up the latch, rather than by pecking it.

[1] C. Lloyd Morgan: Animal Behavior, pp. 149 and 151.

The following tables give the results obtained in the experiments described above:

Series I.

Exp.	Time.[1]	Sex.
1	6:	?
2	Failed	?
3	"	?
4	9:	?
5	2:	?
6	1:	Female
7	:30	"
8	:30	"
9	:25	"
10	:25	"
11	1:	Male
12	:20	Female
13	:10	"
14	:30	Male
15	:30	"

Series II.
(Female.)

Time.	No. of Trials.
3:	?
:45	10
—	3
:30	3
1:	30[2]
:15	6
1:	25
:30	18
:30	11
20:	98[3]
8:	91
3:30	73
:30	8
:25	13
:15	2

Series III.
(Female.)

	Time.	No. of Trials.
1	3 —	?
2	Failed	?
3	"	?
4	4:30	?
5	Failed	?
6	4:30	?
7	3:30	9
8	4:15	9
9	5:00	18
10	1:15	4
11	1:30	15
12	:45	4
13	1:15	4
14	:40	3
15	:30	4
16	:45	4
17	:12	6
18	:15	4
19	:05	2
20	:04	2
21	:20	6
22	:20	5
23	:04	2
24	:20	9
25	:25	8
26	1:20	12
27	1:00	1
28	:04	2
29	:15	3
30	:15	3
31	:07	5

[1] In all these tables the time is given in minutes and seconds.
[2] The fastening was made more difficult to work.
[3] The food was taken from immediately behind the latch and placed near the left end of the box.

Series IV. (Male.)			Series V. (Female.)		Series VI. (Male.)			Series VII. (Female.)	
No of Exp.	Time.	No. of Trials.	Time.	No. of Trials.	No. of Exp.	Time.	No. of Trials.	Time.	No. of Trials.
1	10:50	?	Failed	?	1	Failed	?	4:30	?
2	10:30	8	"	?	2	"	?	1:04	?
3	2:08	5	20:00	?	3	10:10	8	:55	5
4	1:06	5	3:15	?	4	6:03	5	1:30	1
5	3:00	6	:45	8	5	:30	3	3:00	4
6	:50	5	:15	1	6	:03	1	:25	5
7	:40	3	:05	2	7	:16	[illegible]	:15	2
8	2:00	11	:30	12	8	:16	4	1:00	4
9	1:00	4			9	:03	1	:15	1
10	:12	1			10	:35	7	:15	2
11	1:20	7			11	:45	9	:04	2
12	1:00	7			12	:20	3	:37	10
13	:10	2			13	:10	1	:11	6
14	:09	1			14	:03	1	:10	5
15	:06	2			15	:15	2	:58	19
16	:04	1			16	:20	5	:59	8
17	:03	1			17	:35	3	:34	6
18	2:30	3			18	:02	2	:26	14
19	:15	3			19	:09	3	:17	6
20	:15	4			20	:30	8		
21	:15	4			21	:30	5		
22	:10	4			22	:50	2		
23	:12	4			23	:01	1		
24	:05	3			24	:04	1		
25	:04	1			25	:15	1		
26	:09	1-3			26	:04	1		
27	:09	0-4			27	:03	1		
28	:15	-5			28	:40	4		
29	:02	2			29	:40	5		
30	:06	1-3			30	:10	1		
31	:05	2			31	:01	1		
32	:03	1			32	:01	1		
33	:10	1			33	:05	1		
34	:30	1			34	:08	2		
35	:06	2			35	:09	3		
[1] 36	3:30	39			36	:02	2		
37	3:40	27			37	:01	2		
38	:05	3			38	:01	1		
39	6:45	21			39	:10	5		
40	1:12	11			40	:03	[illegible]		
41	:03	1			41	:02	2		
					42	:01	2		
					43	:02	2		
					44	:15	2		
					45	:06	1		
					46	:15	1		
					47	:02	1		
					48	:03	1		

[1] Here the string was taken off and he had to learn a new way to open the door. The string was replaced for trials 38 and 41.

Series I. As a rule the experiments in this series were made twice each day, once in the forenoon and once in the afternoon. There were five males and two females in the large cage when this experiment was begun. It was quite a while before I could tell certainly which one was opening the door. One of the females died just before the fourth test and the other female was the first to be recognized certainly as the one opening the door. But one of the males succeeds in the eleventh test and he does it in so short a time that it suggests previous experience or unparalleled imitation. He profits by it, too, for he opens the door very promptly in the fourteenth and fifteenth experiments. The female operated from the right side of the string and the male in much the same way from the left. I feel pretty certain that what he did in the eleventh trial was his first effort. Of the possibility of imitation I shall speak later. In this series the door was opened by catching the suspended string in the claws and pulling it in and down, thus lifting the latch. This required not a little skill as the bird must hop out from the upper edge of the box, turn partly round and catch the string in its claws. At the ninth test in this series there occurred the most skillful thing observed in the whole study. The female started from the perch in the large cage some five feet above and four feet away from the small box. She attempted to catch the string in her claws as she flew past the top of the box. But she struck the floor some three feet beyond, flew directly back, and this time succeeded in catching the string. In the seventh trial and most of the following trials of this series, there was wheat and corn on the floor outside the box to be opened; but as a rule the food inside had a greater attraction because it was made more conspicuous by placing soaked bread there in addition.

Series II. In this series the tests were made twice daily as in Series I. There were two birds, a male and a female, in the large cage. The male opened the door first in one minute by pecking the latch. However, the next time the female opened the door in the time given under 1 in the table, and continued to do so. In the table will be found the number of trials made as well as the time taken for the animal to get inside the box. In this table it will be seen that the number of trials in the fifth test increases suddenly from three to thirty. This was caused by fixing the latch. The change made it more difficult to raise the latter above the little wire catch. But this increased number is reduced in much the same way as is shown in all the trials. At the tenth experiment in this series, I happened to place the food, which was soaked bread in this case, near the end of the box covered with wire. This so attracted the bird away from the latch that, by counting the efforts made

alternately on the wire at the end and near the door, I succeeded in getting an experiment in Interference and the following quantitative expression for it:

No of Exp	Trials Near the Food.	Trials at the Latch.	No of Exp.	Trials Near the Food.	Trials at the Latch.
1	87	11	4	0	8
2	13				
		9	5	0	13
	10				
		7			
	11		6	0	2
		4			
	20				
		5			
	4				
		3			
3		6			
	6				
		14			
	12				
		8			
	7				
		7			
	5				
		8			

Series III. Here the tests were made four times daily. There were three males and one female in the large cage. The female opened the door by pecking the latch. This table shows very clearly the effects of an over-night interval on the memory. It is seen both in the longer time and the greater number of trials in the ninth as compared with the eighth test, in the thirteenth as compared with the twelfth and in the twenty-first as compared with the twentieth.

Series IV. In this series the tests were usually made three times daily, twice in the forenoon and once in the afternoon. The suspended string as in Series I was used, but as the door was opened by pushing in on the part that extended from the latch to the upper edge of the box, the part that hung down from the wire arm was taken off. The string was tied to a nail and was just long enough to be taut when the latch was in the bottom of the groove made by the wire catch. Any push or pull would lift the latch and thus open the door. There were two males in the large cage at this time and I could distinguish them from the fact that one was brown and the other slightly gray. Brownie succeeded in opening the door first by pushing in the string with his claws. The changes made in his manner of opening the door and the rapid leaving off in the first few

tests of the unnecessary movements made this one of the most valuable of the series. At first he hopped up to the left of the door; on the far end covered with wire; walked along the front side with one foot on the floor and one on the side of the box; and climbed down over the sides from the top. He accidentally struck the right place and the detailed records written immediately after each experiment show that the unnecessary reactions get fewer in number with each successive experiment. In the tenth test he has left off all of them. At about this time he begins to use his bill on the string. Instead of pushing it in with his claws he strikes it with his bill. In the twenty-seventh test he does not cling to the side of the box while striking the string with his bill but pulls the string while standing on the floor. In the thirty-seventh trial the string is removed and he must learn a new way to get in. He does this by striking the latch with his bill and the table shows how rapidly he reduces the number of these and how nicely he is able to discriminate between the box with the string on and the same box without the string. This string was of a very dull color being the common very strong wrapping cord. But he did not seem to hesitate as to what to do and showed the same power of discrimination as the cats experimented with by Dr. Thorndike.

But this change in the method of learning was more valuable for its effect on the other male bird which was in the large cage with B. When the latter was hopping back and forth in the intervals between trials, the other male was following, pecking and running under him. And in the second of this new series he hopped up on the side of the cage much as B. had done. The next time he tried the same thing five times. It was also to be seen that he expected the door to open when B. hopped down after each trial, since he made ready to go in. He still ran under B. and pecked him in succeeding trials, but as B. learned to open the door in a shorter time, and the old fastening was used often, there was less opportunity for imitation. After the forty-first trial B. was found dead. When the box was set in the other male took the right position for opening the door three times. It should be noted that this position was not this bird's habitual way of approaching the box. He, in the beginning of this series, hopped to the top of the box and around it on the floor. Judging from these tests and those in Series I, it would seem probable that sparrows imitate, though just what the nature of this imitation is the data are insufficient to show. Additional experiments should be made in which there is a good opportunity for imitation. Such I think was the case in the above experiment in which the conditions were suddenly changed, but left the bird to be imitated present, with the necessity for the bird doing the imitating to do something as well.

I find that Mr. L. T. Hobhouse has laid down exactly similar conditions when he says: "Thus it would be more likely that one animal would imitate another if both were trying to escape or get food at the same time. Whether under these conditions there might be reflective imitation—imitation based on the perception of another's act and its result to that other—remains uncertain. What has first to be settled is the possibility of a still simpler mutual act—learning by the perception of an event and its consequence—when that consequence directly affects the learner. If an animal sees something done which has the immediate effect of giving it what it wants, then the something done falls within the sphere of interest as above defined. . . . But if (an animal pulls a string) because he has seen it pulled . . . his act appears rather as a practical application of what he has seen. . . . It is quite possible that an animal should get to this point without being capable of the slightly more complex act of applying to himself what another does on his own account."[1]

If imitation is to be found anywhere in animals it seems that the gregarious, quarrelsome, and pugnacious English Sparrow would be one in which we should expect to find it. From the time when the young are able to take care of themselves they go in flocks more or less by themselves. When mating time is over the old ones join these and, as we all know, the English Sparrow is rarely seen alone. The cry of one of his own or another species, as I have often observed, is sufficient to bring all the sparrows within hearing to the spot at once. Such conditions promise much if we can but suit the experiment to the distinctive movement of the animal.

Series V. This series is a short one but has the advantage of being made on a female bird just caught. The tests were made twice daily. In the third trial she opened the door by falling against the string. She made no use whatever of this incident, but opened the door the next time by striking the latch with her bill. This lack of power to profit by results which do not follow immediately from definitely directed efforts has often been noticed in these experiments. This would suggest, probably, that the range of attention in this bird is narrow. The results which fall within this range are readily associated as all the tests go to show. But a result which is removed from the efforts of the animal in either space, time, or otherwise, it does not seem to be able to use with much, if any, profit. The closing records of this bird, as a good many of the others, show the longer time and the greater number of trials caused by an abnormal condition. On the day before the last I was

[1] Hobhouse: Mind in Evolution, pp. 149-151.

almost certain that she would be found dead the next day, and such was the case.

Series VI. Here the experiments were made twice a day until the eleventh trial, and once a day after that. A male and female were in the large cage but the female was removed after the third trial. The male opened the door by pulling the string with his bill. He is the first male to succeed in first learning the thing to be done when there was a female present. Between the twenty-fourth and twenty-fifth trials there was an interval of eight days. In the meantime the bird was caught and the cage moved to another building. The fifteen seconds in the twenty-fifth trial also includes the time which the bird took to pick a grain of wheat out from inside the wire. He really used but little more time than in the preceding trial and he needed to make but one more effort. This only indicates that the Sparrow has a good memory, as later experiments will show also. This series was longer than the others, the tests here being carried on while the color and number tests were being made. These tests often preceded the opening of the food box by only a few minutes. Often there was food on the floor outside the box. Thus we see that a condition of intense hunger is not necessary in the making of these experiments. A few times I tapped my foot on the floor or otherwise started the bird toward the box, after which he continued his chain of reactions and opened the door.

In this connection Mr. Frank C. Bostok's description of the learning of wild animals seems timely. He says: "An animal learns by association. Though it is a common belief, fear is not the reason for his obedience to the trainer's commands. Habit and ignorance are what cause the animal to become an apt pupil in the hands of the trainer. The animal becomes accustomed to the same way of doing the same things at much the same time, and ignorance of his own power keeps him in this state of subjection.

"This habit is developed in the animal by a laborious and patient process. . . No animal is ever allowed to backslide. . . Such is the force of habit that laxity to-day means a desire for laxity to-morrow. . . ." And further Mr. Bostok shows the remarkable force of habit in a lion which, having thrown him down and carried him over to the other trainer was made to let go his hold and forget his anger by the firing of two pistol shots and the trainer throwing his arm around the lion's neck. These were the signals for a change in the regular performance and it worked here through the sheer force of habit, though in quite different conditions.[1]

[1] The Training of Wild Animals, pp. 120, 152, 158 and 159.

The first part of Series VI, perhaps, shows the effect of an over-night interval.

Series VII. A female bird was placed in the large cage by herself and tests were made once each day. She first opened the door by lifting the latch with her claws. The door did not swing far open and she had to push it with her bill. Although she used her claws in the second and third trial, in the fourth trial she used the more direct method of pushing the latch up with her bill. This shows clearly that with identical apparatus each bird has its individual way of doing the same thing. After the tenth test I made the catch longer so that she must lift the latch one half inch instead of only a quarter. This did not seem to trouble her the next time; but after that it seemed to do so. She struck the latch now instead of pushing it up.

The following are some of the conclusions concerning the methods of learning of the English Sparrow: first

(1) The rate of learning is *at first* very rapid.

(2) The great decrease in amount of time required consists largely in locating the part to be worked upon and therefore in the leaving off of unnecessary movements.

(3) Later the gain in time is due to making the necessary movements more rapidly and accurately.

(4) The first opening of the door is due to happy accident; the bird often not being aware at the time of what it has done.

(5) There is no sign of reason in the sense of looking forward and of adapting means to an end. But there is certain proof of a very great ability to profit by experience and some evidence of an ability to profit by the experience of others, as shown in imitation.

(6) The habit of getting into the box is very soon formed and once formed is very masterful. As early as the sixth trial there may be food on the floor around the box and yet the bird neglects that and makes the required movement for getting at what is within.

(7) Its habits are nevertheless still plastic and change readily to fit new and changed conditions. It not only readily adapts itself to changes made by the experimenter; but perfects its own adjustments by dropping off what is unnecessary.

(8) The individual differences are very well marked in all the experiments.

The curves below, Figs. 2, 3, and 4, represent the times which were given in three of the foregoing tables, Fig. 2 corresponding to Series III, Fig. 3 to Series IV, and Fig. 4 to Series VI. It was thought unnecessary to represent the shorter tables by curves since they exhibit nothing which is not true of the longer ones. The distances on the ordinates represent time in seconds, and the successive trials are in-

dicated on the abscissa. It should be noted, however, that in Figs. 2 and 4 the first trial in each is really the sixth and

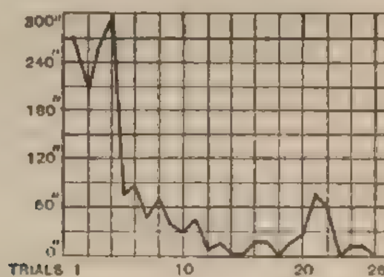


Fig. 2

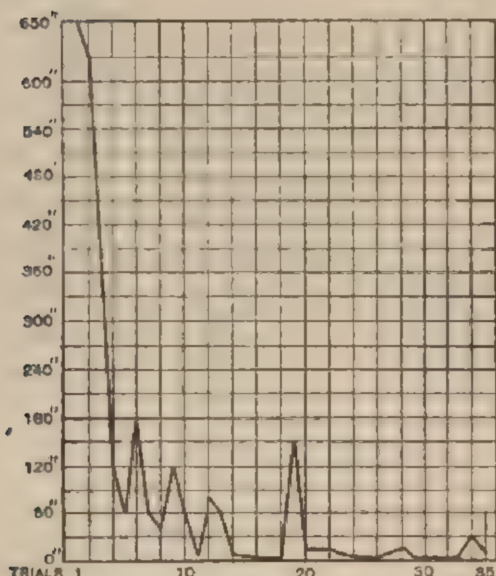


Fig. 3

second in their respective series. If these curves are compared with those of Drs. Thorndike[1] and Kinnaman[2] for the higher animals, including monkeys, although the conditions were not identical, it will be seen that there is a striking similarity in

[1] Edward L. Thorndike: The Mental Life of Monkeys. Psych. Rev. Monograph Supplement, Vol. III, No. 5, p. 11; also Animal Intelligence, Psych. Rev. Monograph Supplement Vol. II, No. 8, pp. 18-36.

[2] A. J. Kinnaman: Mental Life of Two Macacus Rhesus Monkeys in Captivity. *Am. Jour. of Psychology*, Vol. XIII, p. 117.

form. It is necessary that the fastenings used for the birds be very simple. The limitations of the animal's structure will not

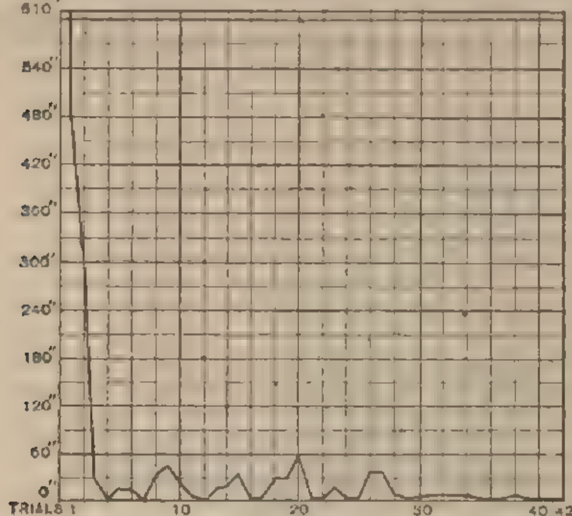


FIG. 4

allow them to be otherwise. Yet the manner of pulling the string in Series I suggests that something more complex and calling for greater nicety of co-ordination would be possible if one should take the time and trouble to work it out. However, the rate at which the "number of efforts" is reduced, as shown in the above tables, is very significant. An animal's "power to profit by experience" is, after all, the best criterion by which to judge of its intelligence. A very stupid animal, if he had a human-like hand would very probably be classed by many as very intelligent. Therefore it seems to me that any animal showing the power of inhibition which is seen in this bird must not be ranked low in the scale of mental capacity simply because of our inability to match its structure and movements with our artificial experiments.

So-called Number Tests.

The attempt made here was to study in the same way as Dr. Kinnaman did with his two monkeys[1] the number sense of the English Sparrow. Ordinary glasses were covered with dark gray paper, of a shade that I found from preliminary tests that the birds were probably the least afraid of. These glasses were placed in holes two and one-half inches apart and large enough

[1] Kinnaman: *op. cit.*, p. 173.

to allow the glasses to extend through the lower edge of the board. The board was three feet and ten inches in length, five inches wide and one inch thick. It was held up off the floor by two cross pieces two inches high. As the glasses expand toward the top there was a distance of only two inches between their upper edges. See Fig. 5.[1]

Fig. 5.

About 1,900 experiments each were tried with one male and one female. The male Sparrow was experimented with first, and for him the food was placed in glasses in the following order: 3, 4, 2, 5, 1, and 3 again. The order for the female was 3, 4, 2, 5, 2, 1. When I began these number tests the large cage had but one door and I could use but one end of the cage; but only a few of the first series of experiments were made in this way as I very soon had a second door put in. After this was done I could enter the large cage at one end, pick up the board, carry it to the other end, place it across the large cage anywhere from near the middle to near the end and leave by the door at that end. This kept the bird at the far end of the cage until I could get behind the screen. The food glass was alternately on the bird's right and on his left as he made successive trials from different ends of the cage. A newly papered food glass was substituted often and irregularly, the glasses next to it were changed frequently, and the board turned round; but no change of this kind ever made any difference that I could notice with the birds' selection. Whether the right glass was chosen or not, the birds were allowed to take one bit of food. The experiment of making them do without when they did not alight on the right one was tried, but this only made them miss the more.

The following tables give the results of these tests, the number of correct choices being underscored and the results of each successive series of twenty tests extending from left to right above this line.

The record was kept on a paper ruled into squares corresponding in relative position with the glasses. The glass on which they first alighted was marked a, the next they went to b, etc. I thus obtained not only a record of their selections but also of their sense of direction and position and in some few ex-

[1] This was so nearly like Dr. Kinnaman's apparatus for his color tests that I have here, with his consent, reproduced his figure, though I used ten glasses.

Male.

No. of Glasses.	Food in Three.									Food in Four.													
1																							
2	4		5	12	8	1		1	[illegible]	1	2												
3	2	7	8	15	12	6	9	14	16	3	2	3	4	3	3	1	1	1	1	2	2	2	1
4	11	6	1	3	7	17	9	5	9	3	5	6	7	10	7	9	7	9	11	8	7	8	13
5	5	5			2	5	2		2	6	4	8	6	5	10	5	8	5	6	9	9	6	6
6	1	2								3	4	3	1	2	2	5	4	5	2	1	2	4	
7										4	2	1	1										
8											2												
9																							
10																							

No of Glasses.	Food in Two.																
1			1		2	1	2	1	1		1					1	4
2	4	6	6	12	14	17	12	11	12	13	18	13	15	16	13	12	14
3	6	8	3	6	1	2	5	5	4	2		2	6	3	5	1	1
4	5	7	3	2	2				2	2		4	1	3			1
5	4				1		1	2	1	3	1						
6	1		1					1									
7												1					
8																	
9																	
10																	

No. of Glasses.	Food in Five.																		
1			1				1												
2	6	3	2	3		2	3	1											
3	6	4	8	6	1	3	3	1				2							
4	2	7	1	1	7	2	6	5	5	3	6	5	9	4	5	6	6	5	4
5	2	3	[illegible]	[illegible]	8	7	6	8	12	12	9	8	8	13	13	13	7	11	12
6	4	2	4	7	4	2	1	5	2	4	4	4	3	3	2	1	6	1	3
7		1	2	1		4			1	1	1	1					1		0
8																			1
9																			
10																			

Male.

No. of Glasses.	Food in Three.									Food in One.							
1										6	9	11	6	5	9	9	9
2			2				3	3	1	7	8	7	9	5	7	9	7
3	0	2	1	4	4	10	6	9	15	6	3	1	3	6	2	2	4
4	7	10	11	13	14	8	6	8	3	1		1	1	3	1		
5	11	6	6	2	2	1	3		1						1		
6	2	[illegible]		1		1							1	[illegible]	[illegible]		
7							1										
8							2										
9																	
10																	

Female.

No. of Glasses.	Food in Three.																
1																	
2	[illegible]	1	2	3	3	10	11	1	8	6	1		2	3	4	2	3
3	5	3	9	3	7	10	7	16	9	12	13	12	7	6	5	10	7
4	5	6	7	10	10		1	3	3	2	5	6	9	8	7	7	8
5	4	5	1	2			[illegible]				1	2	2	2	4	1	2
6	2	2	1	[illegible]													
7	3	1															
8				1													
9		1															
10		1															

No. of Glasses.	Food in Four.																	Food in Two.									
1			1																					1	1		
2	5																	0	4	2	1	0	6	3	4	3	[illegible]
3	1	6	6	3	3	3			4	3	2	3	1	1				3	5	7	9	5	5	7	5	7	4
4	11	8	10	5	6	4	7	8	8	10	7	8	11	12	9	12	12	9	5	6	8	7	8	6	9	8	5
5	1	6		9	7	6	11	11	6	6	7	7	6	6	6	8	5	2	2	1	2	4	[illegible]	3	1		3
6	1			3	3	5	2	1	[illegible]		4	2	2	1	5		3	5	1	4		4					
7	1		3		1	1			1									1									
8						1																					
9																											
10																											

No. of Glasses.	Food in Five.																				
1																					
2																					
3	2	2	2	1	2						1	1	1					1			
4	4	[illegible]	5	4	4	2	6		5	5	6	5	10	8	8	2	7	6	8	5	7
[illegible]	2	7	4	4	8	9	9	11	6	11	11	9	2	[illegible]	6	11	7	5	7	12	10
6	4	4	4	6	5	6	5	8	9	4	2	5	7	7	6	7	5	7	5	3	3
7	5	[illegible]	4	5	1	3		1									[illegible]	1			
8	2	2	1																		
9	1																				
10																					

No. of Glasses.	Food in Two.																	Food in One.									
1													[1] 1	8	4	[illegible]	3	0	1	1	6	[illegible]	7	7	8	7	[2] 15
2	0	0	3	7	4	5	6	8	3	7	6	[illegible]	13	10	13	9	15	0	7	7	4	5	5	3	2	5	5
3	0	7	5	4	5	7	9	7	7	1	9	6	6	1	3	3	2	3	4	6	9	7	8	9	8	8	
4	9	7	4	9	6	8	4	4	10	8	5	5						13	5	3	1			1	2		
5	10	5	5		5		1	1		3		1						3	3	3							
6	1	1	1							[illegible]								1									
7			2							1																	
8																											
9																											
10																											

periments with one of them, of their sense of distance as well.

In experiments of this kind it is very important that after the sparrows have learned to feed from one glass, they should not at once be tested with another. Since in that case the older association interferes with the formation of the new. This interference when the series follow each other immediately is evident in the tables above. In the table for the male Four does not show the effect of preceding experiments with Three because there was a rest of some weeks intervening. But Two shows the effect of Four, Five of Two, Three the second time of Five, and one of Three. It will be noticed that with some of these the interference is greater than with others; but for this no reason can now be given. The female showed the same difficulty in breaking away from Four and Five for Two. Judging from both observation and results, I believe that the habit which the sparrow has of alighting some distance from

[1] Here the two end glasses were taken away, the food glass occupying second place still but where four was originally.

[2] Here the food glass was put in the fourth place but still first in the series.

his food makes it difficult by this method of experimentation to get a perfect expression for his ability to sense position in a series. Yet it will be seen by comparing these tables with Dr. Kinnaman's[1] that the birds begin with as high an initial number of correct choices, that with some of the locations they reach the maximum as soon, and that the percentage of correct choices is in many cases greater than for the monkeys. It should be added, however, that the birds were experimented on in smaller quarters than the monkeys and so had some greater opportunity to fix the position of the glass absolutely by associating it with the definite part of the cage. Yet the board was moved endwise and toward and away sufficiently far I think, to prevent any very constant association with a definite position in the cage.

The results show very few effects of the over-night interval, especially after the experiment was well started.

The records show another element which must be considered in interpreting these results. Usually the male bird flew from his perch, which was about eight inches long and at the middle of the farther end of the large cage at a height of about six feet. In fact, I took off the perches which extended the entire length and width of the cage to make him start more nearly from the same place each time. Yet he did not always use these small perches and by keeping a record of the position from which he started I was able to find some relation between his starting point and the glass selected. If, for example, he flew from the upper left hand corner of the cage he nearly always went too far to the right and *vice versa*. Again, if he walked instead of flying he had to get his bearings anew and often made errors. The manner in which both male and female made ready to single out the food glass was a repeated turning of the head in such a way as to run now one eye and then the other along the row of glasses. The male did this a good deal more than the female and I account for his better results largely through this. He was very deliberate, turning his head often as many as ten or twelve times before making his choice. The female was wilder, more impulsive and hence less accurate.

The place of the food glass in the row of glasses must be the thing which is sensed, since when the series were considerably shortened at one end (the food glass remaining second in the series, but standing much nearer the middle of the cage), the female lacked but one of doing as well as with the full series in which she had been practiced. The same change with *One* made no difference at all in the number of correct choices.

It might be added that the male did not do so well with food

[1] Kinnaman: *op. cit.*, p. 177.

in glass number *One* as with the others. Very early in the experiments with food in glass *One* he could get it almost every time when the board was at one end of the large cage and he seems to have simply preferred to alight on *Two* or *Three* and then hop to *One*. He knew where *One* was and often jumped over *Two* to reach *One*. A reason for this failure to fly directly to *One* may be the fact that it being on the end of the board was too near the side of the cage.

Another source of error was created by getting the bird too hungry. He would fly for the food before I was out of sight; and while he was not wild, my having to leave the cage at the corner and still being where he could see me, caused him to swerve too far to one side. This I tried to overcome by driving him back to his perch at once before he reached the food and not counting that time.

Finally, it may very well be asked whether all of these experiments come any nearer to proving that animals (birds in this case) actually count, or "perceive the relations necessary for counting." The method of experimentation does not require anything more than the location of the member of a series or the sensing of the size of a group. If we do not find in birds the power to count we have in their nice sense for the location of a member of a series or for the size of a group something of that preliminary number sense which Ribot describes as belonging to children and savages.[1] As we shall see the sparrow develops in a short time a very strong attachment for place and it is to be expected that this would help him materially here.

It was said above that the method of recording the results in these number tests made it possible to get a record of the birds' sense of direction. The errors in direction such, for example, as going to the left from the food glass when already too far to the left, or going to the right when too far to the right, were as follows: for the female 38 times in 1,840 tests, and for the male 23 in 1,360.

If each series of 20 tests is divided into four groups of five each, the mistakes of the female are distributed as follows:

First five, 42%; second five, 22%; third five, 19%; and the fourth five, 17%; of the male first five, 61%; second five, 8%; third five, 19%; fourth five, 12%. Although there was an average of *fifteen* series of twenty each for each number for the female and *thirteen and three-fifths* series for the male, 34% of the errors in direction for the female and 26% for the male fall in the first series of twenty tests. I give these results simply to show how early in each series, and in the work with each

[1] Ribot: Evolution of General Ideas, p. 35 ff.

number, the birds learned which way to turn in case they did not alight on the glass with the food in it.

FORM TESTS.

No form tests have been made on the male, and with the female they followed immediately the tests with the food glass in the third place.

The forms were six in number and the size of each was as follows: Hexagonal, 1⅗ inches on each side; triangular, 4⅜ inches; elliptical, 4½ x 2⅞ inches; circular, 3¾ inches in diameter; rectangular, 3½ x 2½ inches; and the square, 2 15-16 inches. See Fig. 6.

Fig. 6

In this respect they were different from the forms used by Dr. Kinnaman with the monkeys as his forms were of different heights as well.[1] These forms used with the birds all have approximately the same capacity. They were made by gluing the one inch poplar boards together and sawing out the box the shape desired in one piece, one-eighth of an inch thick. The bottoms were then fastened in with glue and all were stained black.

The board on which I placed the boxes was the same as that used in the number tests. The food was first placed in the triangular box and kept in this through the whole of the test though the box itself was shifted after each trial to a different place on the board, the place being determined by a programme previously made out. Not only was this food box changed, but the box which the bird alighted on first in each trial was changed also. It was early seen that she could not or did not distinguish the triangular box from the rest and it was thought worth while to see if she would follow the box she alighted on first. Each series consisted of twenty tests. The different forms were tried in the order given in the following table.

It is evident from the results given in the tables below that she showed very little power to distinguish form. She alighted on the 2nd, 3rd, and 4th box from the end of the series, and it made very little difference what the form was. She very rarely followed the food box or any other to a position next to the place it had occupied in the preceding experiment. She succeeded in picking out the right form only when it came to the positions where she was in the habit of alighting, and often she changed

[1] Kinnaman: *op. cit.*, p. 129.

Form Tests. Female Bird.

Box Chosen.	Triangular Box contained food.														Total.
Cir.	1	4	[illegible]	3	3	5	6	1	3	4	4	4	3	6	3—55
Sq.	1	1	4	4	3	3	1	4	3	3	3	3	3	1	3—40
Tri.	4	2	2	3	4	2	4	5	4	4	3	5	5	5	3—55
Rect.	5	2	3	2	2	5	2	3	3	2	4	3	2	2	5—45
Hex.	6	5	[illegible]	3	5	1	3	[illegible]	[illegible]	2	3	3	4	1	4—51
Ellip.	3	6	2	5	3	4	3	3	4	5	3	2	3	5	2—53

Box Chosen.	Elliptical Box contained food.								Total	Rectangular Box contained food.										Total.
Cir.	3	3	2	2	2	4	2	5	3—26	3	4	3	3	3	4	3	3	3	3	3—35
Sq.	2	3	4	3	5	3	4	3	2—29	4	3	4	3	4	4	4	5	3	4	3—42
Tri.	3	4	4	3	3	3	2	3	5—30	3	4	3	3	3	3	4	3	4	2	5—37
Rect.	5	2	3	5	3	3	3	3	2—28	4	6	5	3	3	3	4	4	4	4	4—44
Hex.	4	1	3	4	4	3	2	2	2—25	4	2	2	4	3	3	2	3	3	3	2—31
Ellip.	3	6	4	3	3	4	7	4	6—40	2	1	3	4	4	3	3	2	3	4	3—32

Box Chosen.	Circular Box contained food.								Total.
Cir.	4	5	4	4	4	3	3	4	7—38
Sq.	4	3	5	3	4	3	4	3	3—32
Tri.	2	3	2	3	3	4	3	3	3—26
Rect.	2	3	4	3	3	2	4	3	3—27
Hex.	4	3	3	3	3	3	3	3	1—26
Ellip.	4	3	2	4	3	4	3	4	3—30

from the 3rd to the 4th, or *vice versa*, just in time to miss the right box. Her alighting on the third box first falls into groups as her correct choices in the number tests very often did. The records show that when the form tests were first begun she showed a decided place preference for 2 and 3. This gradually gave way to 3 and 4 and the closing tests show that she had begun on 4 and 5. If she alighted on the third box and found the food-box to her right at 1 she usually turned to the right the next time although the food-box was now to her left at 5. She either did not distinguish or notice the forms, or her associations with place were so firmly fixed that she did not overcome them.

Color Tests.

From the brilliancy and variation in the coloration of birds and from Dr. Thorndike's[1] work on young chicks, perhaps we can rightly infer that birds possess considerable power of color discrimination. It was to obtain some idea of how far this is true of mature birds that the present experiments were made.

The first experiments on color with the Sparrows were de-

[1] Thorndike: The Instinctive Reactions of Young Chicks, Psych. Rev., Vol. VI, pp. 282-291.

signed to show their color preferences. Six shallow dishes some five inches across were covered with the following colored papers—white, yellow, gray, blue, red, dark gray and green. The blue was lighter than the standard blue of the Bradley colors and the green darker than the standard green. There were two birds in the cage during the first series of experiments of this kind and one followed the other most of the time. With both, place seemed to be the determining factor as out of 125 experiments, although the dishes were shifted each time, the bird leading went to the third from the end 54 times, the fourth 48 times, the second 19 times, leaving out the first, fifth, sixth and seventh almost entirely. They showed least fear of the grays and most of the green and yellow. But the fact that stands out here is the strong hold which place has upon them. The bird which followed showed more fear and therefore more choice and when experimented on alone he showed the same preference for place and also a slightly greater preference for the grays, but was rather easily induced to eat from the green dish.

The above experiments were merely preliminary. The experiments proper were made only on the female. These followed immediately after the tests with the same bird on the forms. The same board was used as for the number tests and six of the glasses were covered with the Bradley colored papers —a dark gray, a light gray, a bright yellow, a dark blue, a light green and a dark red. The brightness has not been experimentally determined.

A programme made out previously determined the place of the food-glass as before. Twenty tests were made in each series. The following table gives the result, the colors being tried in the order given:

Female.

Colors.	Food in Blue.					Food in Yellow.										Food in Red.					
Blue,	12	14	13	12	19	16	10	12	14	9		6	3	2		6	6	2	3	1	
Red,	1			1		1										2	1	9	15	14	20
Green,		2	2				2				1		1							1	
Yellow,			2	2			5	1	5	8	16	11	13	18	19	12	9	4	2	1	
Light Gray,	4		3	2	1	2	2	3	1		2	2			1		1	4		1	
Dark Gray,	4	4		3		1	1	4		3	1	1	3				3	1		2	

Colors.	Food in Green.				
Blue,	1	1	1	2	1
Red,	3		2		1
Green,	9	17	15	14	18
Yellow,	[illegible]			2	
Light Gray,		1		1	
Dark Gray,	[illegible]	1	2	1	

These results show that the female Sparrow can readily distinguish the colors used. She does quite as well as the female monkey tried by Dr. Kinnaman[1] for blue and green. She did not do so well for red and yellow. This may be partly explained from the fact that she was more afraid of these. Several times during these experiments she manifested the same thing which we notice so often in our own actions after they have been reduced to habit and changes in conditions call for a change in the order of reactions. She would fly to the blue glass and then go directly to yellow, jumping over several others. At the same time she seemed to show surprise at the fact that she had not alighted on the right one. This, of course, was after the color had been experimented with for some time.

Experiments with the Maze.

The maze was made after the plan given by Dr. Small, by whose permission I reproduce it here. See Figure 7, page 340.[2] It was, however, reduced to one-half the size, 3x4 feet. The alleys were made three inches wide and the partitions four inches in height. No pieces of wood were used to support the corners, but the edges of the strips of wire, one-fourth inch mesh, were unraveled and these unraveled wires run through holes in the wood bottom and clinched. At the top and sides the unraveled ends were clinched to the wire mesh. This gave a maze throughout of the same colored wire and of course very free from landmarks. This test is quite likely to be judged as a very artificial one for birds and one that does not call for the exercise of any one of their instinctive or habitual methods of reaction. Yet these birds work their way through the foliage of trees, through the leaves and plants which cover the ground and through crevices and drain-pipes in and about buildings. But granting that the test is an arbitrary one, success in it argues all the more for the intelligence of the Sparrow as we shall see from the results.[3]

The maze was placed in the large cage with food in the centre, which was covered with a wire lid. The bird, of course, came down and spent a good deal of time hopping round on, and pecking through, this lid. At the opening *o* Fig. 7, I had a door of wire which could be closed by a rubber band and

[1] Kinnaman: *op. cit.*, p. 136.

[2] Small: Experimental Study of Mental Processes of the Rat, II, *Am. Jour. Psych.*, Vol. XII, p. 207.

[3] In the cages with bottoms covered with paper it was a great surprise to me to see them crawl round under the paper in search of food, and one has to force them out as he would a mouse when they remain hidden and very quiet under the paper.

which I held open, until the bird had entered, by pulling on a

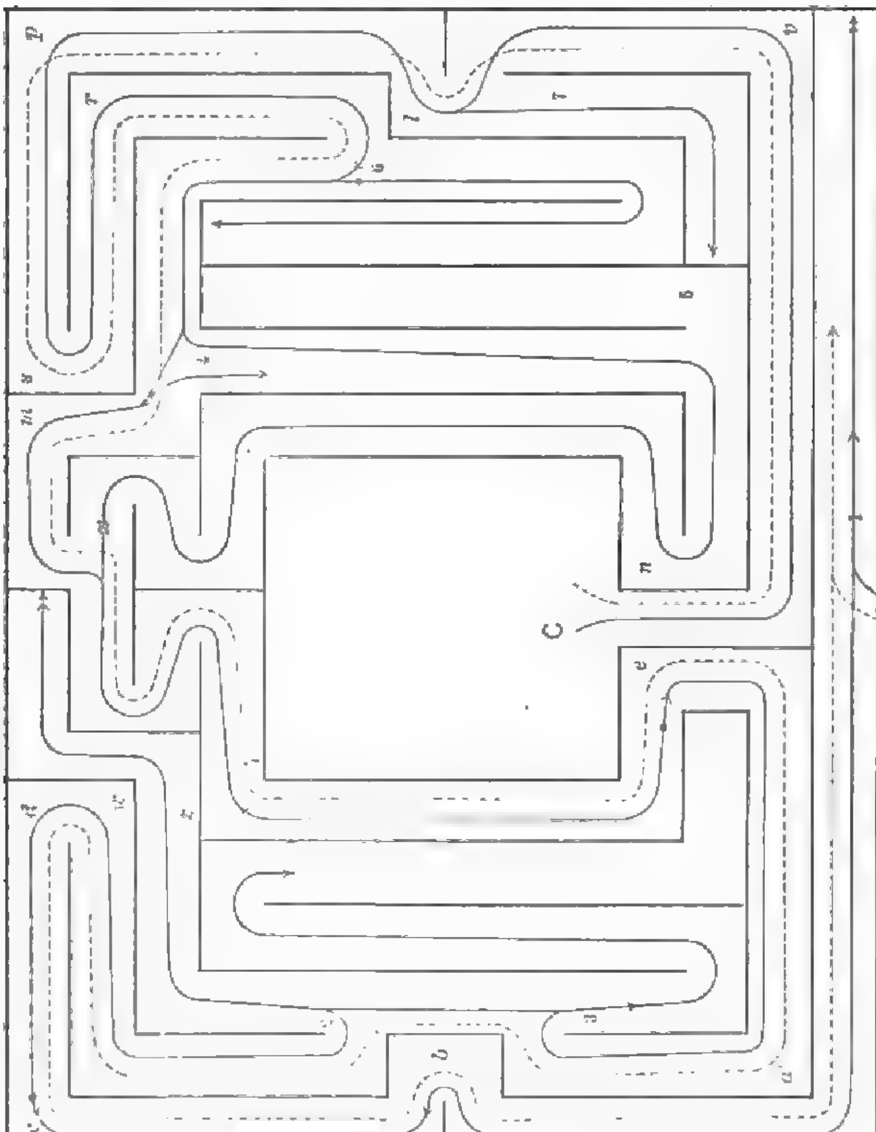


Fig. 7.

strong thread attached to the door and passing through the wire side of the large cage. The loosening of the thread and

allowing this door to close after the bird had entered and the pulling up of the lid over C after the bird had reached the food, nearly always caused some fright and perhaps was in so far objectionable.

In the first experiments I placed a few grains of food just inside *o* to induce the birds to enter. But after their first experience they evidently regarded the maze as a trap, and I have waited sometimes for hours until the bird's hunger should overcome his wariness. I should expect to find such wariness, such inhibition and control, in very few, if any, other birds. This does not mean that the Sparrows did not try the maze to see what it would do. They nearly always in their approach to any new and strange object have the appearance of testing it. They climb down the side of the cage toward the fearful object, fly directly toward it but hover and then away. If they walk toward it, they do not go directly. Their fear is not a senseless one. Some recent comparative experiments would seem to indicate that in some other wild birds *wariness* is less developed.

The time for passing through the maze was taken with a stop-watch as in the tests with the food-box and the number of errors was kept by use of the letters shown in Figure 7. The tests were made once each day and the maze removed from the large cage after each trial. I have succeeded in making tests on one female for seventy-one sucessive days. Also a series of twelve daily trials with another female and nine and six respectively with two males. The general reactions of all the birds toward the maze were pretty much the same. I account for the shorter time with one female by the fact that the others were less habituated to experiment and were much wilder than she was. In fact one of the males was tried with the maze only two days after being captured and he had a broken wing in addition. As will be seen from the table below I succeeded in making only six tests with him and yet he shows the same reduction of time and number of errors as the others. But the wilder birds struggled more to get out of the maze than to get to the food in the centre and were somewhat hindered by their efforts. The same struggling to get out was very pronounced in wild birds tried later with the larger maze which Dr. Small used. His white rats made better records, very probably because they did not spend so much time in trying to get out. The table gives results for the first ten trials with the Sparrows and also for one of Dr. Small's[1] white rats and both of Dr. Kinnaman's monkey's.[2] The numbers represent seconds.

White rat	780	180	240	105	60	90	180	30	60	120
Male monkey,	2700	1800	420	180	900	230	390	285	160	204

[1] Small: *Am. Jour. Psych.*, Vol. XII, pp. 214-218.
[2] *Op. cit.*, p. 187.

Female monkey,	3300	7920	840	420	375	450	210	195	165	135
Male sparrow,	3586	1635	893	1424	1072	729				
" "	2502	1697	374	665	72	67	365	210	169	
Female "	3186	457	768	701	326	155	104	72	330	256
" "	810	1305	850	150	70	340	319	140	435	540

The above table shows that the Sparrows are quite as rapid in learning the maze (that is, make as great gain proportionally) as the rats and monkeys. The graphic presentation which follows, Figure 8, shows this somewhat more clearly. The curves are obtained by letting the first times stand for 100 per cent. and computing the succeeding trials in terms of this. One space on the ordinate represents 12½ per cent.; the abscissa shows the successive trials. Only the first ten trials are represented. Curve 1 represents the rate of learning of one white rat, curve 2 the average of the two monkeys and curve 3 the average for three of the Sparrows, one male and the two females. The male Sparrow with only six trials to his credit has been left out of this average. Considered in this proportional way the birds are but little inferior, if at all, to the rats and monkeys; though on the other hand it must not be forgotten that the absolute distance which they had to travel was considerably less. It must be remembered that Dr. Small allowed his rat to spend the night following each trial in the maze and Dr. Kinnaman's trials came one after the other, while the Sparrows were tested but once in every twenty-four hours. Yet, again, judging from the effect of an over-night interval on the birds in the experiments with the food-box, it seems probable that if tried one trial after the other they would have done much better.

In counting the number of errors I included as mistakes the running back and forth in the blind alley marked 3 (and others as well) and have made them have the same standing as to enter 3 and follow it to its end. This, of course, charges the Sparrows with a great many errors which were not charged up against the monkeys at all. So no comparison can be made on the basis of the actual number of errors. Computing the percentages of the errors for the first nine trials, using the first as 100 per cent. and averaging the results for the two monkeys and those for the same three birds used in the curves above, we get the following table:

Sparrows,	100	75	35	27	23	18	15	6
Monkeys,	100	110	245	18	36	12	20	16

Also by using Dr. Kinnaman's[1] table for the averages for both times and errors in groups of ten consecutive trials for the monkeys, and treating my own results in the same way, the following table is obtained:

---

[1] Kinnaman: *op. cit.* p. 185.

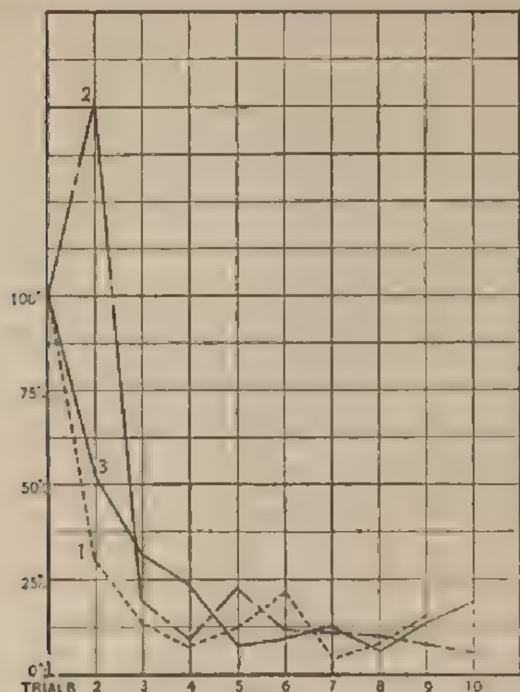


Fig 8

Average Times in Seconds.

	1st-10	2nd-10.	3rd-10.	4th-10.	5th-10	6th-10.
Male Monkey	726.9	73.7	76.	64.4	61.2	67.2
Female Monkey,	2579	127.7	63.6	68.1	55.8	55.
Female Sparrow,	495.9	376.3	48.2	81.4	55.4	33.7[1]

Average Errors.

Male Monkey,	18.5	3.1	3.2	2.2	1.4	2.6	1.5
Female Monkey,	14.1	1.3	1.7	.7	.4	.3	
Female Sparrow,	63.9	46.7	1.8	9.2	4.2	1.8	1.3[2]

These tables show in the same way as the tables and the curves above that the Sparrows are quite as intelligent as the monkeys, if ability to profit by experience is taken as a criterion.

The female Sparrow with which I was able to experiment so long went through the maze without a single error on the 23rd

[1] The average of the 1st-10 trials with another female Sparrow is 635.5 seconds; the averages of the 1st-9 and 1st-6 with two males are respectively 680.1 and 1,553.5 seconds.

[2] The average number of errors for the 1st-10 trials with same female Sparrow is 99.1; the averages for the two males are for the 1st-9 and 1st-6 respectively 62.3 and 95 8.

and 24th trials; also on the 27th, 37th, 41st, 44th, 53rd, 56th, 57th, 60th, 64th, 65th, 66th, 67th, 70th, and 71st. The first time of going through perfectly falls midway between that for the monkeys; the male monkey going through without an error on the 36th trial and the female on the 13th.

The English Sparrow never ceases in his efforts to get through or out of the maze. He seldom stops to preen his feathers or to sit down and rest. He is persistency itself. This agrees well with his popular reputation and it certainly seems to me now that the English Sparrow owes much of his biological success to this strenuous characteristic.

The detailed records show that the sparrows with relative ease avoided blind alleys 1, 2, 5, and 7. They get caught at 3 *h-e*, *xkn*, 4 and 6. At first they spend a good deal of time between *he*, *n-k*, and in 3, by trying to get directly to the food. Alley 6 is rather difficult to avoid. They very often check themselves after entering a little way into 3 or any other blind alley. Two of them quickened their pace very perceptibly when about to reach 6 and at the same time were seen to raise themselves more erect and glance toward the entrance to C.

The birds often avoided entering any blind alley as far as 4 or 6 and, if when coming out of these they returned beyond the entrance to 2, 3, or any other, they very often entered blind alleys which they had just avoided. At times when the one female tested longer than the others was hungrier than usual she quickened her pace and thus ran into blind alleys which it is reasonable to expect she would have otherwise avoided.

Experiments with Designs.

The female sparrow was tried with something very like Dr. Kinnaman's apparatus 35, and 36.[1] Instead of boxes I used the gray glasses surmounted by cards carrying designs. The food was placed in the glass carrying the card with three horizontal black bars and alongside of this was placed a similar glass carrying a blank card. Next the food was placed in the glass with the card carrying a black diamond, and used as before along with the glass carrying a blank card. In the third series the horizontal bar and the diamond were used, the food being in the glass bearing the diamond-marked card.

Here again the place of the food-glass was irregularly shifted at either end of the cage and while the bird was behind me. Twenty tests were made in each series. If the bird alighted on the wrong glass she was allowed to go to the right one and take one bit of food. The following table shows the number of times she alighted on each glass in these experiments.

[1] Kinnaman: *op. cit.*, G, p. 114.

Horizontal Lines,	14	13	15	14	15	16	16	20	18	17	20
Blank,	6	7	5	1	5	4	4	0	2	3	0
Diamond,	18	14	17	16	17	20					
Blank,	2	6	3	4	3	0					
Diamond,	11	14	12	18	18	20					
Horizontal Lines,	9	6	8	2	2	0					

These figures are remarkable because of the entirely negative results obtained by Dr. Kinnaman with the monkeys.[1] The male monkey chose the right box 154 times and the wrong 146 times, the female monkey chose the wrong 30 times and the right 20 times with essentially similar apparatus. It will be seen from the second part of the above table that the Sparrow under the same conditions chose the right 49 times and the wrong 11 times out of the first 60 trials. The rate with which the bird came to discriminate between the horizontal bars and the diamond seems to show that the Sparrow has somehow come into possession of power of discrimination, at least in this particular, which the monkeys have not. It is probably true, as Dr. Kinnaman suggests in a personal letter to me, that the kind of coloration of food and the color markings of the species in question might enable the experimenter to tell in general beforehand what kind of designs the animals would discriminate.

General Summary.

The following conclusions may be drawn from the facts given in the preceding sections.

1. When tested with food boxes the fastenings of which are suited to the bird's structure, and with the maze, the English Sparrows' rate and method of learning are quite comparable with that of other higher animals. He profits very rapidly by experience.

2. There is some proof of ability to profit by the experience of others, or of imitation. However, before any description of the real nature of this imitation can be given, additional and varied experiments are needed.

3. His method of learning is one of "trial and error." There is no sign of reason or looking ahead and suiting of means to an end.

4. The scope of his attention is probably narrow. Any result of his activity which does not follow closely his definitely directed efforts he seems unable to profit by. He has great power of confining his actions to the matter in hand.

5. His persistency is most striking. Most of the birds tried in the complex maze never rested at all after they were once inside. They also returned again and again to make another attempt to enter the food box.

[1] Kinnaman: *op. cit.*, pp. 119-120.

6. These birds, both in the laboratory and outside, have shown the wariness which is popularly attributed to them. Those kept in the laboratory for months failed to show signs of becoming tamed. They test by various cautious means any new and strange object. Their fear is by no means a senseless one.

7. Although ideo-motor action plays a rather large rôle in their movements, they are able to modify their habits readily. They discriminate small differences in the apparatus and adjust their actions accordingly.

8. An interval of eight days between tests with the food-box on the male showed little, if any, effect on the memory. The results in the maze experiments where the interval was twenty-four hours, and the way these compare with the results on the monkeys tried without any appreciable interval, would seem to indicate that the Sparrow has a relatively good memory.

9. The tests on the "number sense," perhaps suggest that if the Sparrows cannot count, they have a very nice sense of position. Their progress almost parallels that of the monkeys, but they had smaller quarters to work in. The one female tried did not distinguish the forms. This may have been because she was so attached to place, or because she simply failed to notice them. This same female distinguished the standard colors, red, blue, green, and yellow, almost, if not equally, as readily as the female monkey. The designs the female Sparrow learned very early to discriminate, while the monkeys gave entirely negative results with the same apparatus. This may be explained probably by the fact that the black lines and diamond on the white card correspond more nearly with the markings of the Sparrow's food, her mate, and other birds of the same and different species. Such is not at all the case for the monkeys and they may be able to distinguish blotches of color, *i. e.*, markings corresponding more nearly to what they have to deal with in real life.

The biological significance of the mental traits mentioned above for the English Sparrow depends in large part on whether they are distinctive characteristics of this bird. Therefore comparative tests with birds of other species are necessary before an interpretation is attempted.

THE SOUL—A STUDY OF PAST AND PRESENT BELIEFS.

By L. D. Arnett.

II

Psychological Theories of the Soul.

Alger[1] states the following as the psychological arguments for the soul:

(1) All motion implies a dynamic mover, matter is dormant, man is an active power, a free will; so there must be in him an immaterial principle, this is immortal. (2) If we admit the human soul to be material, an ultimate monad, an indivisible atom of mind, it is immortal, defying all forces. The soul as such a unit-consciousness is simple, and its power is an absolute integer. A soul is a simple substance (Herbart) not liable to death but eternal. (3) Indestructibility of soul is a direct influence from ontological characteristics. Reason cannot but embrace the conviction of its perpetuity and its independence of fleshly organization. Our life is best defined as conscious force, our present existence as the correlation of that force with the physical materials of the body and with other forces.

In beginning the chapter it is well to mention that modern psychology questions any use of the word soul, unless the author restricts the term, stating specifically how he desires it to be understood. Lotze uses the word soul but makes the proviso that it be used "future-proof." Ribot[2] objects very strongly to the use of the word and thinks it should be omitted from future psychology altogether. James uses the term in a popular way only, and Dr. Royce[3] says, "If your consciousness is merely based upon an existence, which lies beneath the consciousness and which never comes to light as your own present will and meaning, you gain nothing but a name when this unobserved substratum of your own personality is called your soul." The chief objections urged against the use of the word are (1) that it carries with it the idea of substance, from the metaphysical and theological discussions of the past, and psychologists feel that they have cut loose from this. (2) Ex-

[1] The Doctrine of a Future Life, p. 44.
[2] English Psychology, p. 24.
[3] The World and the Individual, Vol. II, p. 291.

perimental Psychology has tended to create an exact science. Psychologists who have been thus trained do not desire to use a term that ascribes immortality to psychic phenomena, the elements of which they attempt not only to study qualitatively and quantitatively but to establish the underlying principles and laws. Those psychologists can, in fact, discuss "soul" scientifically only as a mental development based on material furnished by the senses.

This section presents some of the ideas of psychologists as to the nature of the soul and attempts to study it from their standpoint. The question that presents itself is, where shall we begin, how shall we distinguish the psychologist from the theologian or philosopher. Külpe[1] distinguishes three periods in the history of psychology.

(1) "In the first, mind, the substrate of all psychical phenomena, is identified with the vital principle. This view carries with it a very broad interpretation of psychology.

(2) "In the second, the province of mind is limited by the definition of 'mental' as that which can be known by internal perception.

(3) "The third makes the psychical coextensive with the subjective."

The view presented in the first period prevailed in antiquity; Aristotle was its most worthy representative. It had certain followers during the Middle Ages. John Locke, he points out, as the first representative of the second period. Other[2] writers regard Descartes as the founder of modern psychology, and early representatives[3] as Hobbes and Spinoza. Ribot notes that in the seventeenth century the science of the soul was called metaphysics, and was so used by Descartes, Malebranch and Leibnitz, Locke and Condillac, and that the word psychology was invented by Goclenius, and later used by Wolf as the title of a work. Certain it is that the writings of Descartes mark a new era, and for the illustrations cited in this study we shall begin with him.

As was noted, earlier writers had not differentiated the psychology of man from that of angels and even God. We find that Descartes considers a number of subjects which class him as a philosopher of that time, but he is also an analytic psychologist. Whatever in the life of the human soul concerns the relation of it to the material world he explains as mechanism. Here Höffding notes that Descartes greatly reduced the number of souls in the universe by his mechanical explanations excluding from the category every form of life below man. Permanent material changes in the brain, when the senses are acted upon, account for the association of ideas; these changes influ-

[1] Introduction to Philosophy, p. 55.
[2] Janet and Seailles: Hist. of the Prob. of Phil., Vol. I, p. 35.
[3] Baldwin Dict. of Phil. and Psy., Vol. II.

ence the subsequent development of ideas. As an extended being, the soul can be in contact with the body only at one point. This point, as is generally known, Descartes thought must be in the brain, and more precisely in the pineal gland. This gland is selected as the central point because, unlike most organs, it is simple, consisting of one part only. In fact it is a central part of the brain. The action of the soul on the body and the body on the soul demands the concourse of God; interaction is not prohibited by the complete unlikeness in nature of the body and the soul. Body, and soul or spirit, represent a dualism of heterogeneous entities, separated in nature by an unfilled interval, the existence of our souls apart from our bodies is inferred. The nature of mind consists in thought, true knowledge in clear and distinct thought. The passions of the soul are related to man as motion to body, they require the union of mind and body, they are the ground of knowledge of soul and body. There is but one body which is united with a mind or animated with a soul and that is the human body, animals are mere machines destitute of mind and soul The soul is the mind; without self-consciousness there is no thought, mind nor soul. Animals feel, have sensations and impulse, but not self-consciousness.

"I desire[1] you to notice that these functions (animal) follow quite naturally in the machine from the arrangement of its organs, exactly as those of a clock, or other automaton, from that of its weights and wheels; so that we must not conceive or explain them by any other vegetative or sensitive soul, or principle of motion and life, than its blood and its spirits agitated by the heat of the fire which burns continually in the heart, and which is of no other kind than all the fires which are contained in inanimate bodies."

To this arrangement the soul must be created. On this he says: "I had[2] after this described the reasonable soul and shown that it could by no means be educed from the power of matter . . . but that it must be expressly created, and that it is not sufficient that it be lodged in the human body exactly like a pilot in a ship, unless, perhaps, to move its members, but that it is necessary for it to be joined and united more closely to the body, in order to have sensations and appetites similar to ours and thus constitute a real man." The way in which the body and soul are connected through the passions may be gathered from the following:

"The passions[3] cannot be directly excited or removed by the action of our will, but they can indirectly through the representation of those things which are usually joined with the passions we wish to have and which are contrary to those we wish to reject." Although each movement of the gland appears to have been joined by nature to each one of our thoughts since the beginning of our life, it is nevertheless possible, through habit, to join them to other thoughts. "And such is the connection between soul and body that when we have once joined a certain bodily act to a certain thought, the one will in future never occur without the other."

But Descartes maintains that the soul may exist independent of the body: "Since,[4] on the one hand, I have a clear and distinct idea of myself, in so far as I am only a thinking and unextended thing, and as, on the other hand, I possess a distinct idea of body, in so far as it is only an extended and unthinking thing, it is certain that I, that is my mind, by which I am what I am, is entirely and truly distinct from my body and may exist without it." The subject-matter of mediæval philosophy to a great extent influenced Descartes; philosophy and

[1] Treatise on Man. Mahaffy, p. 175.
[2] Discourse on Method, Part V, Tr. by Veitch.
[3] Pass. 45, 50, and 136.
[4] Sixth Meditation.

psychology are yet undifferentiated. Contemporary with Descartes, in England, Hobbes wrote his treatise on philosophy. This work embodied principles of associational psychology. The mental powers are two-fold, cognitive and motive. The cognitive power gives the imagery of external things, this remains after the object is removed. The motive power involves and is dependent on the function of mental representation.[1] Mechanical laws are applied to psychical activities. In sensation the inward motion by way of the sense organ calls forth an outward reaction from the brain or heart, physical motion is thus involved in a psychical process; some trace, for memory, is always left from a sensation. As the vital motion of the heart is helped or hindered there rises pleasure or pain. Appetite or aversion is the endeavor to or from something, based on pleasure or pain. "Will is the last appetite in deliberating." If anything really exists it is and must appear extended; unless it does it is phantasmal. Ideas and volitions are at bottom activities of the body; the immortal soul, and divine mind or spirit, fall in the province of theology. Soul or spirit is either brain action or nerve substance; the spirit is a physical body too refined to escape the senses, as incorporeal it does not exist. For Bacon, and as noted also by Hobbes, certain lines of investigation fall outside the realm of philosophy under the head of theology.

Seailles[2] regards Malebranche as the founder of experimental psychology. His idea in regard to mind and body is that we have a clearer knowledge of our bodies than of our minds. "Although we know the existence of our souls more distinctly than the existence of our own bodies, or of the bodies that surround us, still we have not so perfect a knowledge of the nature of the soul as of the nature of the body." We know the soul through consciousness only, and for this reason imperfectly. "The consciousness which I have of myself informs me that I am, that I think, and desire, and feel, and suffer, etc., but it does not tell me what I am, or the essence of my thought, or of my will, my feelings, my passions, and my pain; nor do I learn through it the ratios between all these things, because again, having no idea of my soul — being unable to see its archetype in the Divine World — I cannot discover by contemplating either what it is, or the modes of which it is capable." The only connection between body and mind is natural and mutual correspondence between the thoughts of the mind and the traces of the brain.

The soul[3] cannot produce nor possess ideas, they are and remain only in God; what we see and know is through Him alone. Malebranche was a follower of Descartes. Locke is regarded as the founder of the empirical method of psychology. According to him the soul is originally like a piece of white and blank paper. There are no innate ideas. All knowledge has its basis in experience; this may be external, taking the form of sensation, or internal as reflection, depending on the place of the object of knowledge, whether it belongs to the world of external sensible objects, or to the internal operations of our mind. The senses convey from external objects into the mind that which, in the latter, is the source of ideas, viz.: sensible qualities. The mind, employed through the ideas already acquired, is the seat of operations, in some of which it is active, in others passive. When the mind considers these activities and states and reflects on them, the understanding receives another set of ideas, which cannot arise from the things without; — such activities are perception, thinking, doubting, believing, reasoning, knowing, and willing. From one of these

[1] Robertson-Hobbes, pp. 123-135.
[2] Janet and Seailles: Hist. of the Prob. of Phil., p. 36.
[3] Fischer: Descartes and His School, pp. 569-77.

two sources spring all our ideas. Previous to the first sensible impression the soul no more thinks than it does subsequently in dreamless sleep. That the soul always thinks is as arbitrary an assertion as that all bodies are continually in motion. The ideas of pleasure or delight, of pain or uneasiness, and of existence, unity, power, and succession are conveyed to the soul both through the senses and through reflection. Qualities are of two kinds: (1) primary — those of bulk, figure, motion, etc.; (2) secondary — those of color, sound, smell, etc. No contradiction is involved in supposing that God has annexed to certain motives, ideas, which bear no resemblance to them. The complex of mental life is the result of experience. Thinking is an activity of the mind as motion is of the body, not its essential characteristic. External objects occasion perception through impressions; the mind is not able to avert this; as a passive organ it is acted upon and fashioned. Locke defines self[1] as "that conscious thinking thing, whatever substance made up of (whether spiritual or material, simple or compound, it matters not), which is sensible or conscious of pleasure and pain, capable of happiness or misery, and so is concerned for itself, as far as that consciousness extends. Thus every one finds, that whilst comprehended under that consciousness, the little finger is as much a part of himself as what is most so. Upon separation of this little finger, should this consciousness go along with the little finger, and leave the rest of the body, it is evident that the little finger would be the person, the same person, and self then would have nothing to do with the rest of the body. As in this case it is the consciousness that goes along with the substance, when one part is separated from another, which makes the same person, and constitutes this inseparable self; so it is in reference to substances remote in time."

Locke's psychology marks an epoch because it attempts to solve the problem of mind from the lower side, as distinguished from explanations of the soul in definite relation to God. Spinoza's logical systematization of the emotions places him in rank as one of the early psychologists. He is a follower of Descartes in many instances. He examines in detail the relations between psychical and physical processes. The mind is[2] part of the infinite intellect of God; and when the statement is made that it perceives this or that, it is affirmed that God has this or that idea, not in so far as He is infinite, but in so far as He is manifested through the nature of the human mind, or constitutes the essence of the human mind. The mind is the idea of the body, *i. e.*, the correlate in thought of body in extension. His definition of emotion is as follows:

"Emotion,[3] which is called passivity of the soul, is a confused idea, whereby the mind affirms concerning its body, or any part thereof, a force for existence, greater or less than before and by the presence of which the mind is determined to think of one thing rather than another." The soul is defined as "thought" or a succession of ideas, or the sum of ideas; the ego does not exist, the relation of the soul to God is impersonal. The mind and the body are one and the same thing, conceived either under the attributes of thought or extension. We do not know how mind acts on the body, but every sensation answers to a bodily condition. The soul can imagine nothing, nor can it recollect anything that is past except while the body exists; it is not only immortal but external. This in brief represents Spinoza's main ideas in regard to the soul, a little in advance of those of Descartes.

Hume[4] followed the views of Berkeley, except in regard to a sepa-

---

[1] Locke. Human Understanding, II, xxvii, 17.
[2] Ethics, II, 11 cor.
[3] *Ibid.* part III, prop. I
[4] Bain: Mental Science, p. 205.

rate soul or spirit. By some he is regarded as the founder of association psychology. All notions that express relations of necessity, all supposed cognitions formed on the basis of connections between things, rest, ultimately on the association of ideas. Following Berkeley, he claims that substance is unknown to us—we have no perfect idea of anything but a perception—that is different from substance. If the self[1] or ego existed it would be substantial, hence known. It is nothing but a complex of swiftly succeeding ideas, beneath which an imaginary substrate is supposed to exist named the soul, this latter is an illusion. "It is like a stage, across which feelings, perceptions, thoughts, and volitions are passing while itself does not come into sight." The soul being a complex we cannot truly speak of its immortality. To gain an idea of the psychological aspect of the soul it is necessary to give the leading thoughts of psychologists at different periods, but in this study only a comparatively small number of such can be considered. The one change that has taken place dating from late mediæval times is the gradual release of psychology from the realms, first of theology and later of philosophy, and the tendency more and more to attack the problems from the standpoint of experience and experimental data. The mental content is not considered alone from the standpoint of *a priori* analysis, but, having some knowledge of the sense organs, furnished by a growing knowledge of the body and the development of physiology, the problem is attacked from its lower side, as distinct from the theological view. This method of studying the soul aspects has tended to separate it entirely from its direct relations to God, which it earlier sustained, and identify it with mental processes entirely.

In Germany the release of psychology from the dominance of philosophical systems has taken place more slowly than in other countries. Thus while Kant has rendered a great service in pointing out the lines for an exact study of psychology, he is known better as a philosopher. In his teachings he denied the existence of the soul as a substantial entity that could be known, and the self as object could only be inferred. Using his own expression:

"There[2] does not then exist any rational psychology as a *doctrine* furnishing any addition to our knowledge of ourselves. It is nothing more than a *discipline*, which sets impassible limits to speculative reason in this region of thought, to prevent it, on the one hand, from throwing itself into the arms of a soulless materialism, and, on the other, from losing itself in the mazes of baseless spiritualism. It teaches us to consider this refusal of our reason to give any satisfactory answer to questions which reach beyond the limits of this our human, as a hint to abandon fruitless speculation; and to direct, to a practical use, our knowledge of ourselves—which though applicable only to objects of experience, receives its principles from a higher source, and regulates its procedure as if our destiny reached far beyond the boundaries of experience and life. . . . The unity of consciousness, which lies at the basis of the categories, is considered to be an intuition of the subject as an object; and the category of substance is applied to the intuition." The unity is one in thought, by which no object is given, and to which the category of substance, which always pre-supposes a given tuition, cannot be applied.

In internal intuition there is nothing permanent, for the Ego is but the consciousness of one's thought. The self or soul which we posit back of internal phenomena, is a mere idea, the object of which may be thought as substance, but no intuition can be given, so cannot be

[1] Inquiry Concerning the Human Understanding, Sect. V.
[2] Meiklejohn. Transcend. Dialectic. Book II, chap. 1.

known. The subject can never be predicate, and we err when we so arrange it. Empirical psychology is the open road along which to extend our knowledge of the mental life. In brief Kant regarded the soul as an inference. In England the association psychology was early developed. As a representative of this school, J. S. Mill may be taken, although representatives might be selected who state the doctrines of the school equally well. "If[1] we speak of the mind as a series of feelings we are obliged to complete the statement by calling it a series of feelings which is aware of itself as past and future; and we are reduced to the alternative of believing that the mind, or ego, is something different from any series of feelings; or possibilities of them, or of accepting the paradox that something, which *ex hypothesi* is but a series of feelings, can be aware of itself as a series The opposition of the ego and non-ego, subject and object, spirit and matter, reduces itself to the opposition of sensation considered subjectively and sensation considered objectively." Matter is the permanent possibility of sensation. Our notion of mind is that of something permanent—opposed to the perpetual flux of the states of consciousness, this "permanent" for mind as well as for matter may be only a possibility. Our idea[2] of mind is reduced to nothing more than the idea of a series of actual sensations, and of the infinite possibilities of sensations which may realize themselves under appropriate conditions. The view of mind as a succession of states, an association of ideas, does not invalidate the idea of immortality. "It[3] is as easy to conceive of a succession of sentiments, a thread of consciousness eternally prolonged, as of a spiritual substance which always continues to exist," any arguments in proof are as applicable to the one as the other. This view need have no deleterious effect on one's idea of God. If the Divine Spirit be considered as a series of Divine thoughts (since we infer the Divine nature from the human), prolonged during eternity, then the existence of God is assumed to be as real as one's self.

Coming to more modern writers in Germany, we note the views of Herbart. The[4] soul is a simple substance not only without parts but with no plurality whatever in its quality. The ego is not a unit but a plurality. It is the junction of a series of representations, and is constantly changing its place. It is the result of their combination, their union in a single substance being necessary. It is an unchangeable real[5] and enters into various relations with other reals still conserving its identity. The soul originally was not a representative force, but it became such because it was stimulated to self conservation by other beings. It has its seat in the brain. The simplest representatives are sensations, they serve as symbols of the disturbing reals, and may disappear from consciousness, but not from the soul. For Lotze[6] we may note the following: The co-operation of physical forces is not sufficient to explain the unity which characterizes psychical life, material events of external life cannot cause ready-made sensations or ideas, they can only give signals which the soul must translate into its own language and conversely inner states of the soul are only the occasions for the activity of material organs. The material organs prepare and supply the material for the soul, and on these it exercises its force, thus working in the interest of higher spiritual activities. When the material is given the higher spiritual activities of the soul come into play themselves. Given the different psychical

[1] John S Mills' Hamilton's Phil., p. 212.
[2] Ribot English Psychology, p. 118.
[3] Ribot English Psychology, p. 119.
[4] Lehrbuch zur Psychologie, part 3.
[5] Ribot. German Psy. of To-day, pp. 24-67.
[6] Microcosmus, I, 163-180; II, 135 143.

phenomena, presentation or ideas, these react on the soul and feeling is set free, reactions from feeling on the soul sets free expressions of the will. In the Microcosmus Lotze observes: "The soul neither comes fortuitously to this or that particular body, nor does the body create the soul by its organization; rather are souls a creation of the Infinite, who in this creation, proceeds by a self-given law. Our personality is not, however, compounded of body and soul; rather does our true essence lie exclusively in the soul, and the body is but the most intimately affianced part of the external world, which a higher power has given us as exclusively our own." The spirit is something higher than the soul. In the Spirit is the unity of our being, our true Ego. The soul is but an element in its service. At death the soul passes away, the spirit ripens to a new existence. We turn now in a brief review to the ideas of recent writers.

Recent views of psychology are of much wider scope, wider in the sense that the psychologist is awakening to the fact that, from the empirical standpoint any contribution to the history of the mental development of the race is of great value but it has a wider significance in that it includes careful studies of many forms of animal life as well.

These contribute to an understanding of the development of the mental life. The effort of psychology to free itself especially from metaphysical nomenclature has given rise in recent times to the "new" psychology, a so-called psychology established on a scientific basis and one in many instances without a "soul." Not without a soul in some sense of the word, however, but in it an endeavor is made to avoid the use of the word, and much that it has implied in the past. If there is reference to the soul as has been noted in this section it is, in many instances, prefaced by a limitation of the use of the word. The following modern views are given in brief:

For Wundt: "So long as one considers the soul as an independent atomic whole they are able to grant it an independent existence along with the body, but when we let that metaphysical hypothesis fall, and turn to experience, observation gives us a group of functions, united with definite psychic processes. This latter view grants no independent existence either within or without the body, but we must connect and represent it as unchangeable except with the changes of the bodily existence."—Menschen und Thirseelen, Vol. II, p. 436.

Lewes thus defines his position:

"Together with the present sensation there is always a more or less complex group of revived sensations. . . . . The term soul is the personification of this complex of present and revived feelings, and is the substratum of consciousness (in the general sense), all the particular feelings being its states."—Physical Basis of Mind, p. 414.

For Porter:

Since the time of Descartes "in all the varieties of psychological and physiological theories, those who have held the soul to be spiritual and immortal have almost uniformly and unanimously held that the agent of knowledge and feeling is distinct in essence from the principle of life. G. E. Stahl (1660-1734) 'maintained that the soul was active in the formation and functional processes of the body, as well as in the exercise of the conscious activities,' but he connected with this theory certain extreme doctrines which seemed to be inconsistent with its spirituality and independence of matter, as well as with the plainest facts of experience. Physiology of recent times thus developed, also psychology, favors a theory intermediate between that of Descartes and Stahl, the identity of the vital and spiritual forces. Thus the force or agent which at first originates the bodily organism, and actuates

its functions, at last manifests itself as the soul, in higher forms of activity, viz., knowledge, feeling, will. The principle of life and of psychical activity is one. Vital phenomena precede the psychical. The energy of the two are proportional, consciousness depends upon unconscious activities. Soul is adapted to the body and acts on matter yet the body is moulded by the soul and manifests it.—Human Intellect, pp. 36-40

Everybody accepts the truth that his soul exists and that it is an immediate substance. The principle that we call soul has the quality of consciousness or self-consciousness; consequently it is an absolute unity, since the substance of its being is extended and divisible it cannot be material.—Dessoir: Geschichte der Neuer Deutschen Psychologie, pp. 151-152.

The following quotations may be given:

"The soul, then, for us is simply our immediate experience, which we take as belonging to a thing that has past and future, in a way just analagous to that in which we construct anything in space and give it identity. We trace our soul backward, and construct it from our given experience. . . . This, then, is the picture of a soul which I have tried to suggest; not a ready-made machine working on certain material, but a growth of material more like a process of crystallization, the material moulding itself according to its own affinities and cohesions." —Bosanquet: Psychol. of the Moral Self, pp. 7-9.

For us the soul is a natural force. It stands in a natural relationship to the body but is not corporeal. It is to be distinguished from blind force as expressed in matter.—Schultze: *Vergleichende Seelen Kunde*, p. 136.

"Psychology is the science of the mind. Instead of appealing to forces that work mysteriously, we can now, since 'soul' has been severed from the material world, introduce a purely mechanical explanation of nature. . . . No one can deny that there are sensations and ideas, feelings and decisions; and in saying that psychology is the science of the mind, we mean by mind, to begin with, nothing more than the sum of all these inner experiences. . . . Concerning the inner relation between mind and matter, we teach nothing; we suppose only that one being works in both."—Höffding: Outlines of Psychology, p. 67.

Sully observes that psychology as a science of mind, "does not discuss the question of the ultimate nature of spiritual activity, or the substance of mind, and the related question of the immortality of the soul." These it hands over to the branch of philosophy known as Rational or Inferential psychology.—The Human Mind, Vol. I, p. 4.

"Psychology may be defined as the science of mental processes. . . . Ideas, feelings, impulses, etc., experienced by me during my life constitute my 'mind.' Mind as used in every-day conversation means much more than this; it means something 'immaterial' or 'spiritual.' . . . It means a something which lies behind the particular manifestation of our mental life, just as the thing seems to lie behind the attributes of the thing. Looked at in this way, however, the term 'mind' takes on metaphysical implications, and therefore has no place in psychology.—Titchener: An Outline of Psychology, p. 5, 9.

"'Subjective' or 'subjectified' processes, facts of 'consciousness,' 'psychical' or 'mental' states will mean for us no more than this—that part or aspect of the experiential fact which is dependent upon the experiencing individual . . . and 'consciousness' itself or 'mind' will in our terminology merely denote the sum total of all these particular phenomena. We shall nowhere discuss anything like a 'transcendental consciousness,' a 'substantial soul,' or an immaterial spirit."—Külpe: Outlines of Psychology, p. 3.

There is an involuntary movement of the mind; this movement is according to a necessary law and implies a nature. "The laws of logic are as necessary, to say the least, as that of gravitation. So, also, in the laws of sensibility, when the considerations are given; and in the various combinations of Intellect and feeling, including animal wants and passions. The force which produces these necessitated movements, is other than that which builds up the physical organization. With modifications it is common to all sensitive and perceptive life, to the animals as well as to us, and though the word has often a different and higher meaning, may be called the Soul.—Hopkins: Outline Study of Man, p. 253.

"By the *mind* or *soul* is meant the thinking principle, that by which I feel, know, and will, and by which my body is animated."

"*Mind* designates the animating principle as the subject of consciousness, while soul refers to it as the root of all forms of vital activity. Spirit is of still narrower extension than mind, indicating properly a being capable of the *higher, rational*, or *intellectual* order of conscious life."—Michael Maher, S. J.: Catholic Philosophy-Psychology, p. 1.

"We do not need a soul separate from our every-day mind, any more than we need two bodies,—one reserved for the State occasions of life. Conscience and ideals must be willing to come close to homely things, must live in touch with our commonest acts, or they may as well be wanting. So that in making no separation of the soul from our most familiar processes, psychology will do the spiritual life no harm."—Stratton: Experimental Psychology and Culture, p. 306.

We have presented the ideas of a number of writers on the subject. What can we gather from a survey of them? If we begin with Descartes, we observe that his mechanical consideration of animal life reduced the number of souls, by refusing to grant that animals have such and recognizing them only in the human race. He did not regard the subject of psychology as a study of mind *per se*, but in order to something else. The dominant interest was not one of psychological analysis. As Ribot[1] observes during the seventeenth century the science of the soul was called metaphysics. Beginning with Bacon and including Hobbes, Locke, Hume and others, the English school in general, the soul was relegated to the field of theology, mind alone being discussed. Locke did much to establish psychology by beginning with his *tabula rasa*. This was like starting from the opposite pole. In Germany the influence of philosophy existed for a longer time; the effect of this can be noted from the ideas expressed. There was a gradual tendency to narrow the view of mind or soul, and a passage to more abstract principles. For example, from analyses we have it reduced to a "a series of feelings," or a "complex of sense and apperception," or identical with "vital force," or the "sum of inner experiences," or a "series of mental processes," etc. These are the results of mental analyses. Such a course of events in psychology—following out the line of analysis, has served a useful purpose.

[1] English Psychology, p. 23.

But the ground has been trodden over so much since the time of Kant that instead of analysis it might be better now to reverse the process, and take a constructive view of mind. It has been demonstrated from the results obtained that mental analysis is no longer a field productive of new material. Since evolution has become an established fact, psychology has not yet had time to fully adjust itself to a system that regards life as a serial whole. The entire animal series with man at its head becomes a field for mental research, and instead of depending on analysis alone, or even a study of mental development in the child, psychic manifestations can be noted all along this series, which, when correlated with the development of mind as it begins in the infant, gives us a field for constructive work. This is the meaning of genetic psychology. In this field several stages of the development of mental life can be recognized, or we may designate them as so many phases or view-points of the soul. Genetic psychology is really the "new psychology." Organic life at every stage manifests psychic elements, or possess certain psychic correlates; and psychology as a study is forming itself into a series that in some way parallels organic evolution. This is the newer picture we wish to present and from this point of view, from constructive elements, to observe some of the different ideas of soul. Dr. G. Stanley Hall is responsible more than any one else in this country for the setting of psychology in its proper relation to evolution as the term is now generally understood.

First we have what from the standpoint of the animal may be termed the biological soul. Porter recognized vital force as fundamental, this force, the principle of life, later develops, becoming synonymous with the soul or psyche. Külpe's classification recognizes this stage, and a more complete treatment from this standpoint is worked out by Ward [1] and Cope.[2] Under this head falls the totality of push upward as identified by Aristotle, also Schopenhauer's will to live.

The soul thus becomes co-extensive with life itself. Extinct species represent the loss of so much of the psyche. Since the dead far exceed the living thus far so much is lost and nonproducible. A study of soul from this point of view must be purely objective. Comparison is a valuable aid. The vegetative, nutrient part of the soul is one of epi-phenomenon. Extreme plasticity is herein presupposed, corresponding in many respects to the protoplasm itself.

The species may be regarded as a type of soul. This may be termed the phyletic or race soul. For classification Jaëger's[3]

---

[1] Psychic Factors of Civilization.
[2] Primary Factors of Organic Evolution.
[3] *Entdeckung der Seele.*

view of animal life may be taken. He regarded every individual as possessed of a specific type or quality of soul, and the species manifest this quality as distinct from other species, far more sharply than any single individual. The revelations of the soul of any species are (1) the characteristic odors emitted, by means of which, any species may be identified from related ones; (2) taste, a mark revealing itself in the flesh, and by means of which the specie may be identified. While these marks of distinction may be of little significance every distinct species of higher animal life are to a certain extent typified by traits of character. These distinct traits of character coalesce in the life of the human individual. The phylectic soul represents a differentiation of the biological soul, it is far more limited. It is adapted to certain sets of conditions only. Each species may be regarded as representing a quality of the psychic whole finding its culmination in man.

A third view is that of the individual soul. This is the type represented in the writings of Royce,[1] Schiller,[2] and others. It is a special form of the phylectic soul and is the result of heredity. In this view much that is pre-existent determines the character of the soul. It includes the vitality of the individual.

A fourth view may be regarded as that of personal consciousness. This is our own experience. It is the sum total of conscious reactions. It is that part of the psyche that is dealt with most largely by philosophy. It is represented by some as based on memory, pleasure and pain, or is merely a group of sensations, etc. It is composed largely of volitional experiences. Its origin may be said to be the "hedonic threshold."

A fifth and last view is that of attention; this is the narrowest and represents merely a cross-section of the present moment. Here consciousness comes to a focus. For Herbart it is the unity of apperception, and might be so regarded for Wundt. As the focal point shifts over the experiential, psychic elements of the soul, the attention may be now one and now another element.

In this view of the psyche as a product of evolution, the object of genetic psychology is to trace the relation between these aspects of soul. Soul life is homogeneous throughout the animal series, that of man the highest product. To understand what is meant by the human soul we must refer back to those lower levels and get a larger view of what experience means.

From an outline like the above we get a picture of the evolving soul-life. As different from analytic psychology of the past it represents[3] a change of study from subjective to objective

[1] The World and the Individual, part II.
[2] The Riddle and the Sphinx.
[3] Ward: The Psychic Factors of Civilization, p. 125.

psychology, from feelings to intellect. From this manner of viewing soul we can only describe what phenomena it presents, but we cannot define it.

Studies of the Soul Based on Data Collected by Means of a Questionnaire.

A series of questions,[1] the answers to which would imply certain definitions of the soul, was sent out to a number of people for the purpose of ascertaining present ideas. In reply to these questions 124 returns were received, 64 males and 60 females. The ages of those replying vary from eight to sixty. The aim was to make the investigation as inclusive as possible, —the answers embody reports from persons educated in the public schools, and all grades to the degree of doctor of philosophy. About three-fourths of the returns, however, are from college students.

The data is suggestive rather than conclusive on any point.

One question to which a number of replies have been received was: "What experiences led you to think of the soul the first time?"

Of those who made reply to this question the following answers were received:

Parental teaching, 5 males and 5 females; Sunday school or church, 6 males and 1 female; Revival meeting, 2 males and 1 female; teachings of the Bible, 1 male; influence of other persons, 3 males and 1 female; thought of death, 1 male and 2 females; a picture of material hell, 1 female; consciousness of wrong doing, 1 male.

M., 23. "I saw the trees and earth, they did not move as I did, were apparently insensible to heat and cold, and to bruises, and did not think. Here I caught a glimpse of the soul that makes us human."

These are reminiscent ideas and bear out the testimony of Dr. Street's study that the individual first comes to know of his soul as something in relation to psychic activities. The results of Dr. Street opposed the theory of innate ideas, and led to the conclusion that the soul is the product of the psychic activities of man himself.

Of present experiences that lead to thoughts of the soul, the following may be taken as typical:

F., 22. When I think of the purpose of life.

F., 24. Experiences of every-day life.

M., 34. Moral responsibility.

M., 39. Moral responsibility.

M., 21. Religious discussions and studies in psychology.

M., 22. "Thoughts of eternity and poetry touching on soul or some such subject."

F., 26. Death, also contemplation of any beauty or wonder in nature. Any experience that arouses highest thoughts and emotions.

F., 43. "Anything that brings up religion or psychology."

F., 23. Philosophical or psychological reading, church service, sermons, or death of a friend.

F., 28. Reading and observing development of character.

---

[1] Studies involving partly the same line of investigation will be found in the *American Jour. of Psy.*, Vol. IX, pp. 350-395. The Early Sense of Self, by Dr. Hall. *Pedagogical Seminary*, Vol. VI, pp. 267-313. A Genetic Study of Immortality, by Dr. Street.

F., 22. Is led to think of the soul "when touched by something grand in music, art, nature, or human character," also by any moral victory in her own life.

M., 21. Conscience.

M., 22. Any religious address or religious thought.

F., 20. Death of a friend or acquaintance; reading or hearing of spiritualism.

M., 42. Work as a minister, funerals. Also studies in psychology and sociology.

M., 31. "The rising and setting of the sun, birth and death of day; also death of a fellow being."

F., 29. "Sitting by the bedside of a dying patient."

M., 20. "Experiences where my life is concerned or after pleasure and amid solitude."

M. "Sad rather than joyful experiences are apt to lead me to think of it."

M., 19. "Any moral or ethical idea or question, which on reasoning back towards its ultimate origin involves a consideration of the soul."

M., 27. "Observation of the wonders of nature, and man whose capabilities are infinite, standing at the head of creation."

M., 20. "The reading of books on morals, a study of the Bible, listening to sermons. The presence of sickness, sadness, trouble, etc.

M., 23 "I think of the soul to-day when my attention is called to some of life's subjective phases,—anguish, prayer, love, music, art,—these things bore straight through the objective world and we know that there is something which we term the soul for convenience."

M., 27. "Feeling that *I* am *I*, a thinker, feeler, doer; an immaterial, spaceless, invisible, energizing somewhat, wholly different from the sensations conveyed through the bodily organs."

M., 25. "I am most frequently led to think of it when meditating upon some kindness, friendship, and love; in connection with or when beholding something beautiful, wonderful, or mysterious; and when a friend or some one of interest dies."

M., 47. "Anything that strongly suggests the self-interest in life and my relations to the world of 'others.'"

In noting these considerations one comes to the conclusion that those replying have something in mind, when they speak of the soul, that is not implied in the teaching of psychology, even though they have studied the subject as many of them have. Their ideas are testimony of religious teachings, or of the *feeling* of moral responsibility, or they refer to sentiments or emotion of some kind that affect one deeply, early religious training, and all that it implies has been stamped too deeply to be replaced by the results of analysis. It is as though the education of the intellect after all is merely on the surface and the feelings are immeasurably larger than cognition. The idea conveyed in many of these replies, more plainly shown than in the definitions given, is that of a something, existing, of some kind, that can be touched by emotions of sadness, beauty, wonder, love, music, etc., these things relate to the soul as they understand it because they call it to mind.

The number of definite answers received in reply to the question as to what age they first thought of the soul, would not justify any conclusion, but the age seems to vary from three years (in two instances) to eight or nine.

Material idea of soul. Of those who at some time thought the soul to be something material, 34 males and 36 females made reply.

Seven males and eight females thought it was made of *human flesh*.

Six males and three females thought it was made of some light, *transparent* material.

Three males and six females thought it was *mist*, *cloud* or *air*.

One male and three females thought it some *substance*, hard or soft.

As to how it was identified:

Three males and one female thought the soul was identical with, or similar to, the *body*.

Five males and two females thought it some *part* of the *body*.

Three males and one female thought it was some *organ* of the *body*.

Three males and three females thought the soul to be identical with, or similar to, the *heart*.

One male thought it was the *brain*.

One female thought it was the *breath*.

Four males and two females thought it was an invisible *being*, developing in the body.

Four males and two females called it an *angel*.

Three males and five females identified the soul with *mist*, *cloud* or *air*.

Three females thought it was an indescribable *mass* of something.

One female thought the soul was a little *flame*.
One female " " " " white *butterfly*.
One female " " " " small, white *dove*.
One female " " " " *something* with *wings*.
One male " " " " a small, *airy object*, pointed.

As to shape:

Nine males and six females thought the soul had the form of the *human body*.

One female thought it was like "a dim, white, *flat surface*."

One female thought the soul shaped like the *sole* of a *shoe*.

One female thought of it as a vague *shadowy outline*.

One female thought it took the form of *two oysters*, side by side, and connected at the top.

Two females conceived of the soul as *oval* in shape.

One female thought it was *round*.

As to material, shape, form, etc., of childish views, the data only strengthens that already collected,[1] and as has been suggested [2] these views of children parallel the notions of primitive man. This parallelism is brought out very forcibly if a comparison of these reminiscent views be made with the studies I have collected on primitive notions of the soul. All those replying, sometime during their childhood had thought of the soul; in most cases they were able to give the instance in which the idea was first brought to mind. The picture of heaven,—the dwelling place of the soul—a description usually very beautiful to the mind of the child takes firm root. With this idea of heaven, as the place where the good souls dwell, and from which the bad ones are shut out—the child associates at once the idea of the soul as that part of the person surviving death; this picture and all that it implies to the child becomes very precious to him. He likes to talk about heaven, to learn all he can about it because he may dwell there sometime, the soul thus becomes something that must be cared for, at the same time, however, the childish imagination, unable to think of this part of his nature, associates it with some material object.

As to the age when the change of ideas takes place, only those stating positively were selected. To this question, 13 males and 7 females replied.

Between 10 and 12—Five females and two males.
" 12 " 15—Three females and three males.

[1] Dr Hall *op loc.*, p 372.
[2] Street. *op. loc.*, p. 277.

Between 15 and 20—Six males.
" 20 " 25—One male and one female.
" 30 " 40—One male.

This point has been brought out more forcibly in Street's returns, since he had a larger amount of data than is here given. In nearly every case of adult experience a change occurring during the adolescent period was noted, yet only those stating definitely the age when the change occurred have been selected.

Where the soul is located.

Those who have at any time fancied, or who now fancy, the soul as located, within or without the body, replied as follows:

In the brain, four males and six females; in the head, five males and two females; in or near the heart, eight males and thirteen females; in the breast or lungs, two males and three females; in the entire body, two males; in the trunk somewhere, one male; anywhere above the diaphram, one female; around the head and trunk (as a vaporous substance), one male; exterior to, but near the body, one female; in the sky, one female.

Anything about which we think relates itself to something else; this association has led to the location of the soul. And this leads again to the connection of soul and body. The views selected are not reminiscent, but present ideas. The following are selected:

F., 28. "A spirituality dwelling in the physical body throughout."

M., 42. "I think of the soul as dwelling in the body, as permeating the whole body as a spiritual substance."

M., —. "Like perfume about a rose."

M., —. Thinks of it as permeating the body.

F., —. Thinks it pervades every fiber.

M., 40. Thinks "concomitance partly commends itself."

F., 43. Likens connection between soul and body to "electricity and the machine it runs through."

F., 23. "I think of it as diffused more or less over me."

F., —. Thinks the soul is encased somewhere in the body.

M., 19. "I fancy the soul as residing in the head in connection with the brain."

M., 19. "I fancy the soul as connected with the whole and entire body, with its centres in the heart and in conscience."

M., 21. "I have fancied that the body is a 'vessel' or the medium through which the mind has its expression and being."

F., 26. Sometimes fancies the soul as a distinct, separable something lodged in the body during its earthly career.

F., 23. Used to fancy the soul "connected with the body much as the works of a watch are in the watch case."

F., —. Used to fancy the soul "floated about in the body."

M., 20. "I think it is in the body or just something that is merely association with it."

M., 21. Thinks of the soul "as part of, perhaps combining the higher and nobler qualities," of a person.

M., 27. "I fancy that the soul has merely a temporary home in the body. I have always thought of each as being separate, and as going together for a purpose."

M., 26. "I now think the soul connected with the body as the mind; perhaps they are the same."

M., 47. Thinks the soul and body are inseparable, that is, "They never existed apart."

Any boundaries marking off psychology from philosophy are at once transcended by many of the above ideas which suggest discussions of scholastic times. They are further suggestive of the idea that religion with which the soul is associated, as can be seen from many of the

citations, is a separate field from that of philosophy, and of the two types, the influences that affect the religious man are more general and appeal to the masses of people; while those affecting the philosopher are more specialized.

As to the origin of the soul, sixteen males and thirteen females replied.

Nine males and four females believe that the soul comes to the body at birth; four males and four females, with the beginning of the life of the body. Two males think the soul is wrapped up in the embryo. One male thinks the soul does not come until the child's mind is capable of real thought; and one female thinks it comes with the awakening of consciousness.

These ideas are suggestive although they differ as to the period of the child's life when the soul is supposed to enter the body. In Dr. Hall's splendid study[1] the soul unfolds and develops from the materials of its environment. Baldwin[2] attempts to trace the social development of the self—the stages of its growth as they are formed—from contact with other persons. Street observes that the growth of the soul parallels the growth of the body. As will be noted from the answers most of them merely refer to the time of the inception of the soul.

Reminiscent ideas. As to how the earliest impressions were regarded and some description of these, the following may be taken as examples:

F., 20. "My earliest notion of the soul was as a part of my body. I thought it was a part just over my lungs and heart, and that in death the angels came and took this away, and flew with it to heaven."

F., 22. "Probably about 7 years old I associated it with my body, an inner organ, near to or the same as my heart. It was white when I was good, and spotted when I was bad. Later I thought of it as an angel with white wings."

M., 21. "I thought of the soul as an object, where it was situated I do not know only it was in the trunk somewhere. I thought of it as a small airy object, pointed, and I thought that after death some way or other it got out of the body and in some way escaped out of the house and then went directly to heaven. How it now assumed shape and lived I could never make myself understand."

F., 19. "My earliest notion of the soul was of its shape rather than of what it really is. I saw an indescribable mass, light gray in color, something the shape of an egg, more oblong than round; but it seemed as if this at times changed its shape, according to the moods the possessor was in towards God. For I conceived the soul to be nearer to the Almighty than any other part of the body and more closely directly concerned with God. From something connected with one of my earliest physiology lessons, I got the idea that the soul was located near the heart, in the central part of the body."

F., 20. "I thought the soul was of the same shape as the body until my tenth year. I thought it was encased somewhere in the body."

F., 22. "My earliest notion of the soul was that it was a misty, vaporous form, intangible, and yet never breaking into pieces or flying off into atoms like vapor; it was located somewhere near the apex of the heart, but escaped at death, and, changing its form, as a volume of smoke does, it gently and slowly found its way, in a direct line, to the home where it was always to remain, after taking a human form though not a human body."

F., 20. "I was four or five years old. I thought of it then only be-

[1] *Op. cit.*
[2] Social and Ethical Interpretations.

cause I heard people speak of it. I never had a clear idea of what it was. It seemed like a white, thin cloud mass.

"The form seemed the same as the sole of a shoe. About four years old. I never thought of it as located, it floated about in my body."

M., 23. "I was probably 8 or 10 years old when I first thought of the soul. At first I saw it in form of an angel, probably caused by seeing the pictures of angels."

F., 43. "At the age of 8, I thought it was similar to my body and by putting this off the soul would be revealed and that its beauty or ugliness depended upon my thoughts and actions.

"I thought that God made souls and put them into bodies in a very material fashion, very much as yeast might be kneaded into bread."

M., 26. "About 12 years. I thought some kind of organ indescribable located in or about the heart. I used to think the heart of man was the soul, and that the heart would never die nor could it be destroyed. This view was also strengthened by the fact that the hearts of animals are so hard to cook or burn to ashes."

To one who studies the reminiscent returns of early childhood, there is something akin to sacredness in the simplicity of the views expressed. The child-like faith has accepted all these pictures which involve the survival of the soul and with which it is associated. Such thoughts as these, with others stating similar temporal ideas and offering promise to the child, form the hope of its early life. They are events to which it looks forward. During past ages such pictures have been the hope of the race, just as the savage looks forward to the happy hunting ground. Who can tell how much they have promoted the development of humanity?

They are the elements forming much of the early mental food of the child. Not much depends on the method of teaching these beliefs, but if they are omitted are we not withholding from the child things it demands? Shall we teach them? Shall we teach the child things that have to be corrected later? With reference to the soul, heaven, etc., most people would say "yes." If, as for Herbart, Interest is the dominant thing—then myth and all the folk-tales dear to child life have their place, while if we follow the sometimes too utilitarian idea of attempting to teach nothing that will have to be untaught, some of the things for which the child-mind may hunger will be omitted. There is good soil in the mental life of the child for flights of the imagination based on ideas connected with the soul, in fact he pictures another world with its inhabitants, the ideas take firm root, and they are so vivid that in most cases they are remembered until old age. Adolescent views of the soul may be gathered from the following:

F., 43. "'Childish notion' replaced by an idea of soul as an immaterial thing, yet still resembling the material *me*."

M., 40. "At 12 or 13 years of age thought the soul 'an immortal something, parallel with the mind.' 'An abstraction.'"

M., 26. "Yes. My idea about the soul is different now. At one period of my life—from 16 to 20—I thought the soul separate from the mind."

M., 19. "At about 12 I began to think of the soul as being immortal, and not made of material substance."

M., 19. "I thought the soul had a human form when about the age of 13 or 14. The form was exactly that of the human body."

M., 23. "Of late years my idea of soul has changed. I have never studied the soul much, but about 12 or 15 years of age I began to consider the soul as something without form that dwelled in the body. When considered that the body decayed I could not think of the soul having form."

F., 24. "Yes. I thought it was a small round something—I was then about 13 or 14 years of age."

M., 21. "About 14. Thought it was an essence."

The opinion now generally held of the expansion of the mind at the beginning of the adolescent period is here illustrated. The old material ideas are cut loose from and new ones peculiarly individual are formed. The character of these changes have been brought out in some of their different phases of late,—especially former studies here at Clark University. While, as was noted above, only twenty stated definitely the time when their ideas changed, many more stated, indefinitely, the time as falling within the adolescent period. Several speak of the change as being to one of an abstract or immaterial substance of some kind. This they have gained largely from three sources,—conversation, reading, and their own thinking. Judging, however, from the replies, conversation and individual thought play the larger part. The study of psychology is claimed by some as the cause of the change. From its effects one says, "Now I am entirely unsettled and have no definite notion or idea of the soul." Several claim that they are unable to define their position from recently studying this subject; the study of physiology, and the reading of different books. Cicero, Emerson, George Eliot, and other books are mentioned as influential. Of those not having college training the Bible is relied upon in most cases at the critical period. It is suggestive of the need of a special literature for this period,—and perhaps even for this subject.

The effect of psychology may more effectually destroy the early impression but the changes come without this, and there may be other studies that lead to worse effects than this.

Three negative replies were received. One of those answering had received only a common school education, one is by profession a dentist, the other while still a college student has spent two years in the study of medicine. The following extracts from their replies are given:

M., 43. Dentist:

"'At what age did you first think of the soul?' When I was very ignorant of the laws of nature. 'What did you think it was?' I thought it was something which some infinite substance or being had injected or put into me to live and carry my identity after the death of the body in another world they call heaven. 'What did you think it was?' I thought it was the life of every one. 'What is your present idea of the soul?' My idea is that the substance or thing called force is usually called or thought to be the soul. I arrived at my conclusion by reading and thinking both—comparing ideas.

"In my natural and spontaneous thinking I have come to the conclusion that I know as little about the soul as Spencer and I do not care about a thing that I think no one knows anything or can know anything about. We can understand and know something about material things, then why should we bother ourselves with immaterial things?"

As to the future life: "I would prefer to sleep the dreamless sleep. I would like for every one to be as kind, good and forgiving to their fellow creatures as they possibly can and I would like, if there should be such a being as a *God*, for him, her or it, to be as kind and gentle as was Mr. Ingersoll, Voltaire, Paine and a host of others that I could mention."

M., 23. American; candidate for the degree of A. B., 1903, studied medicine two years. "At about the age of 16 I thought of the soul as existing and occupying space within the cranium. It seemed ethereal, without shape or mass. Later, I thought it to be something apart from my ordinary self, something more than human. Perhaps a fre-

quent recurrence of thoughts about the nature of God caused the change in my conception of the soul.

"At the present time I do not believe in the existence of the soul. I think that human life is the product of evolution and that in the beginning all life, both animal and vegetable, was the same, or that they had a common ancestor. All life manifests the power of growth and reproduction; the mere differentiation of function and the acquiring of powers of judgment, reason, etc., do not seem to me to warrant the belief in the existence of the soul. The law of the indestructibility of matter cannot be applied to the phenomena of life. The mind may be completely destroyed; mental processes cease when the body dies.

"If the soul exists in the human adult does it not also exist in the infant, in the embryo, in the original cell in which that particular being took his beginning? It is impossible for me to reason out such a state of affairs. If the soul is a fact, should not all life possess it?"

M., 28. Common schools. "I do not think I have a soul. What is commonly called the soul is that part of a human being which is supposed to exist and be immortal. What is called the soul is really the mind. Biblical teachings first led me to think of it. Daily observation and reflection leads me to think of it as a superstition with which a considerable portion of mankind is afflicted.

"I have never thought of the soul as having shape or form, but have considered it my emotions, which I can feel, and which can cause pain or gladness, bring out in my actions and words the good and bad. I now consider what is called the soul to be the emotions, a creature of the mind, the mind a creature of the brain and animal organism, a body. I do not think of the soul as existing anywhere, except in the imaginations and faith of a lot of people, who have no reason for believing in it other than they have been educated to believe in a thing they have never seen and no one else has seen. My conclusions are from my own thinking."

It will be observed that the first writer speaks of force, and from the men to whom he refers would probably be classed by orthodoxy as an infidel. The second is a thorough-going evolutionist and no doubt, as for many biologists, soul has no place, and mind itself is merely a product of matter. The third believes the soul to be the emotions, merely a product of the mind, *i. e.*, of the imagination, this the result of his own thinking. It has often been observed that the study of biology, or even a preparation for medicine, expands the somatic field and its importance and consequently contracts the psychic world.

The following returns are exemplary of what may be termed the theological view of the soul. The orthodox idea expressed by clergymen, and those strongly influenced by religious training to such an extent that they have not been much affected by any contradictory teaching. The following view is from a minister, a university graduate with theological training:

M., 39. "Yes—I *am* a soul or personal being; never say I *have* a soul. In childhood I thought my soul was a *part of me*. Later I came to use *soul* as identical with the *I*, the personal and moral self-consciousness.

"The question as to what it was made of did not occur to me. That childhood idea was evidently impressed on my mind from without. The changes that came as I met other views and criticisms of that view, and came to think somewhat independently, were rather in the line of development and filling in of detail than towards contrary views.

"My present idea is already stated. 'I *am* a soul,' *i. e.*, a self-conscious centre of personal activity with a sense of responsibility for

my deeds, words and thoughts. As such self-conscious centre of personal activity I expect to endure after the change of death. This view is the result of many factors in which my own thinking has largely had the function of passing in review, rejecting, or accepting, or combining elements from many sources. From 8 to 14 years of age I was surrounded by spiritualistic believers of the very highest type. At 15 I joined the Unitarian church. During my college course (at Bowdoin) I was brought under Congregational influence. In the University I became familiar with Oriental philosophies and religions as well as undergoing the usual theological discipline. I have also had some training in science and have a special knowledge of botany. In my thought the soul has a closer connection with the body in waking moments than in sleep, in intense work and feeling than in idleness, in health than in sickness. I am convinced that the soul may temporarily leave the body under certain conditions and return to it again.

"My imagination of the souls of dead people practically amounts to an indentity with their bodies; yet my intellect tells me that while a body,—*i. e.*, form and substance—may be necessary as a basis or accompaniment to personal self-consciousness it can never be its essence. Gross or ethereal it is not the body we mean when we say 'I' or 'He.' I imagine differences of form and feature, differences of knowledge, and differences of character between souls of the dead. Those who died many centuries ago would presumably differ from those recently dead by so much as the conditions to which they were subjected for so long a time differ from conditions here. It is a matter of pure imagination.

"I conceive souls to differ in themselves according as they have lived well or ill, to differ in capacity, outlook and attitude towards environment. The environment would presumably differ also to some extent, as differences in make-up would lead to different choices and different outside pressures just as under the conditions with which we are familiar."

F., 32. University graduate. "My ideas, I should say I derived from the teachings of others in the beginning. Next the knowledge I gained from books emphasized them. And since I have been capable of giving the subject any serious consideration I do not remember to have ever fancied the soul as having form. It always appealed to me as a mysterious, impalpable eternal power belonging to each creature and modified by the earthly actions of the creature.

"I am more thoroughly convinced of the soul's reality. The fact that we pass through all sorts of experiences while all the physical senses are at rest seems to me to prove that they are only vehicles, the real power is something outside and beyond. My ideas concerning the soul have not changed very decidedly. I believe that the capacity of our enjoyment of the future life will be the measure of our development of this life; and our suffering the same way. When I begin to speculate as to what eternity will be like I usually end with the thought that we are too much of the earth earthy to have any notion of it and am satisfied to leave it all with Him who knoweth best."

M., 54. Graduate of college and Theological Seminary. In answer to the questions replies:

"I am a soul. I habitually think of myself as an immortal being. Can't remember much about my early conceptions as to what the soul was, or what it was made of. Simply thought of it as something immaterial and other than the body. My ideas have not changed but are clearer and more definite. Study of the Bible, psychology and theology have gradually added to and enlarged my conceptions. I have tried

to conceive of the soul as having form and shape, or something corresponding to these as belonging to immaterial or spiritual entities. In my mind the spirit form corresponds to the material. This idea is the result of thought in later years. I think of the soul as in some sense occupying the whole physical tabernacle. Or I am a soul occupying my whole body, which though not essential to my conscious existence is necessary to my completeness.

"My present idea is that it is a simple, immaterial, substantial, sentient, intelligent entity, having what corresponds to local form, capable of moving from place to place, and naturally clothing itself in the material human form. I have derived this idea from books and my own thinking mainly. Most largely from the Bible,—such passages as I Cor. 15th Chapter; II Cor. 5; Rev. 20, etc.

"I have thought of the soul or spirit as dwelling in the whole body having some sort of a vital connection with the nervous, arterial and other systems of the body,—a connection, however, that is as yet incomprehensible. I think the soul was conceived in the womb with the body. I think it leaves the body when the vital connection with it is severed, and this is at the instant when the body may be pronounced as dead. 'The body without the spirit is dead.' The soul cannot sever its own vital connection with the body by any power of the will. But when some external force, like disease, or violence, or an accident or a shock, does sever that connection by intercepting the vital process, I conceive of the soul thus released as *ascending* from the body as if from a weight that had been holding it down. This idea may be instinctive or derived from scripture passages like Eccl. 3:21. I think of the soul as connected with the body as closely and inevitably at one time as at another, though the thoughts of the soul may have freer and wider range at some times than at others—as in dreams, visions, telepathic communion, etc. . . .

"The physical differences in bodies as to sex, age, culture, etc., suggest to me corresponding differences in the souls that occupied them, except as to mere physical infirmities and limitations. I regard the souls of those who died long ago substantially the same as those who died to-day.

"I conceive of the souls of the dead, especially of the 'dead in Christ,' as having larger physical and psychic powers, freer and more extended movement, greater knowledge, nobler disposition, etc., though as somehow suffering a limitation to be supplied by their glorified bodies. As to their own past, the righteous recognize God's mercies and praise him for them, while the wicked can only review it with wretchedness and remorse. I think they remember living friends and feel an interest in them, as the parable of the rich man and Lazarus teaches. And that they are conscious of the presence of each other, and feel mutual love and fellowship, or hatred and repulsion, according to character and condition. I think the righteous dead, though they are 'the spirits of just men made perfect,' are still capable of learning and developing."

The theological idea of the soul, as may be observed, is changing from what it has been in the past. Instead of the soul being regarded as something God creates and puts into the body, instead of observing that "I have a soul," the term "I am" is used. One minister says he used to regard the soul as something plus the body, but cannot now hold that view. The idea of an entity of some kind, having shape or form, is still preserved. Many persons, as is noted in the above, regard the soul as more closely connected with the body at some times than at others, especially during work and activity. As to future existence, the ideas have not changed greatly from those of the Patristic Fathers.

Psychological. The following notions show the influence of the teaching of psychology on early impressions and may be classified as psychological views as expressed by the average person. The extent of education is noted in each instance.

F. Normal school graduate. "Mind and soul mean the same to me now in one sense. Still my old spiritual idea of the soul as apart from intellect has never been quite lost. My childish notion regarding soul was the outcome of my own imagination simply."

M., 19. In college. "The age at which I first had any definite idea of the soul in my mind was between the years 6 and 10. After this first idea of the soul, which was in some way shaken and disfigured, my idea of the soul became much less definite. While in some ways my ideas remained unaltered, the form and abode of it were entirely undefined. This change came when I was about 12 years of age. And to say the truth during the past few years of my university life, and especially since studying psychology, I find my idea of the soul growing less and less definite as far as its separate existence is concerned, and becoming more and more involved in and co-existent with mind. As nearly as I can now define it, my conception of the soul is: an ethereal entity existing in the mind."

F. College student. "The soul is the sensations, perceptions, memories, etc., that live after death. It has no form, is something that cannot be seen. As to the location, I should say it is in the mind. This is the relation of mind to soul. I think the spirit and soul are the same."

M., 32. Doctor of philosophy, teacher of psychology. "I have almost lost the early notion and cannot definitely recall it. It has changed by imperceptible gradations into a present notion of *mind* (or soul—I use the terms interchangeably) which yet seems to flit from region to region of the brain with the stream of consciousness, always covering a considerable area. It no longer has the "foggy" appearance, and indeed is quite indescribable, but is confined to the *brain* and mainly at least to the brain cortex. The changes from the early notion have come almost wholly from my learning about the brain, and when I think of soul or mind at present there is always, I think, some image of *brains* that I have handled and seen in my study of neurology.

"I make no distinction, in my habit and thinking, between soul, mind, and spirit, except that soul seems a larger thing—to include the unconscious, temporarily forgotten part of the psyche. I suppose, too, that *spirit* keeps something of my old notion of it as a light airy something that *goes up* when we die—it has a more ghostly, quick-moving, time and space-transcending quality than either *mind* or *soul*. Probably my notion of the original meaning of the Latin *spiritus* has influenced this. Mind has long been largely synonymous with *intellect* with me, and I find it difficult to make it include the feelings, then, as a psychologist I have often argued for the use of 'mind' for the whole psyche.

"I have come more and more to think of mind or soul as the *fundamental* thing about the psycho-physical organism, and that mind constructs the body more than body produces mind. That is, heredity is a *psychic* rather than a *physical* matter, is memory. As the soul was itself, with but a *single cell*, as the body, so it may persist whenever adult body drops away in death, and may construct another body, possibly, when the environment becomes suitable for the purpose—a very different body, perhaps, suitable to a different environment.

"These are but *dreams* about the soul, but the describe a conception of it that goes with me now as the old 'gray vapor' image went with me as a child."

F., 43. Graduate of college and university. "I have thought of the soul, mind or self,—the name which I apply to it depends upon the connection; in a psychological discussion I should probably call it the self, the ego, the me, or the unifying principle of consciousness; in a religious connection I should be likely to use soul, and in ordinary conversation, mind. . . . .

"I cannot remember definitely at what age I first thought of soul but I can, from external circumstances of which I know the date, state that I had definite ideas about it at the age of 8. I thought it was similar to my body, and by putting this off the soul would be revealed and that its beauty or ugliness depended upon my thoughts and actions. My ideas have changed from time to time but I cannot locate these changes in time. At the age of 12 I had outgrown the idea given above, but cannot tell when it happened or whether it was a growth too slow to be noticed. It was replaced by an idea of soul as an immaterial thing yet still resembling the material me.

"I have always thought of the soul as having shape or form as given above. I always used to think of the soul as located somewhere, usually in the sky. The tendency to do so is still present at times.

"My present idea of the soul is the unity underlying states of consciousness. It is probably derived from books, other people and thinking combined.

"The only thing to which I can liken my idea of the connection of soul and body is to electricity and the machine it runs, though that is a crude simile. At one time I thought of it as permeating the body like a gas but I cannot tell at what age I thought this. I see no reason why the soul should not begin when the body does, prenatally. I have never had any idea how it came since I lost the childish one that God made souls and put them into bodies in a very material fashion, very much as yeast might be kneaded into bread. It seems to me that the soul leaves the body when consciousness ceases. I suppose I think of it as floating off into space somewhere if I try to envisage it. The soul seems to me most closely connected with the body in full waking consciousness and greatest activity.

"I usually think of the soul as expressed in conscious states without envisaging any particular form. If I think of form at all it is a copy of the body but without material substance. I conceive souls as differing in development, therefore no two would be precisely alike, but apart from that I know of no difference that the time in which one lived would make.

"The only difference which I think of as existing between the souls of the dead and the living is the freedom from bodily limitations in time and space. With that freedom it seems to me that the past would be more clearly seen and differently viewed, and the affections stronger, purer and freed from selfishness. Under such conditions learning and improving seem the natural result."

Philosophical ideas. Classed as philosophical the extracts of the following may be given. Few of the returns indicate any philosophical system worked out.

F. College student. "My first idea of soul remained with me until I was about 10 years of age; then I began to reason with myself about it, and to listen to others talk of it. My original notion gradually faded, and for several years I had no notion whatever of it. Then, at about 15, I began to form my present notion: I believe the soul is an atom of the all-knowing, all-loving, all-creating power called God; that it always has existed in some form or other, and always will continue to exist. As the power creates, it infuses itself into its creatures, so that every living thing, plant and animal, contains a spark

of the fire which cannot be extinguished. Following out this plan, then, it is unjust that one of these sparks should be placed on earth as a poor, dumb earth-worm, while another is an intelligent, deep-minded human being. For this reason, I believe that every atom of Life-Power will be given the opportunity of completing its cycle; it began from the original Power, it will complete its development, and again return to the Power. I do not say that I believe in transmigration of the soul from the lower to the higher forms, or from animal to the human form: I have not settled this point to *my own* satisfaction, nor do I expect to do so. Nor can I reconcile the Life-Power in plants with that in man. But I *feel*, rather than *reason*, that such a soul exists in them.

"I think the soul is composed of two parts,—spirit and mind. I have never considered the spirit as different from the soul, excepting that it is the *Life* element; the mind is the intelligence element; the part that is developed and broadened during life; even the 'spiritual education' is only a higher, purer mindedness, and is mental. If the soul is immortal, as I firmly believe it is, then both spirit and mind exist after death, but the mind is not as *highly organized* as the spirit, if such a term could be applied to something which always was. The mind is largely under our own control,—its broadening and development or its entire neglect—and may be so infused with wrong ideas and notions that all we have spent a lifetime in learning will have to be unlearned hereafter. But there is no arbitrary phase of the spirit; it was and will be, and we can merely change its form by taking life."

M., 47. College and university. A teacher of mathematics but a student of philosophy.

"(b) The permanent '*I*.'

"(c) The same as the '*I*.'

"(d) They have grown in clearness and definiteness mainly as the result of increased knowledge of *self* as a knowing, willing and sentient being. There has been no *radical change of idea* in my experience of *self*. Only a development with increased knowledge and general experience.

"2. (a) Yes.

"(b) Certainly, I *am* one. (A soul.)

"(c) The same as to myself.

"4. (a) Yes, the form of the body. I have not to my knowledge ever dissociated the form of the soul from that of the body.

"5. (a) The soul is the permanent self.

"(b) Came to the body when the body came to it. They *never existed apart*. No soul without body. No body without soul.

"(c) At death the corpse is no longer a 'body.' Its functions have ceased. Both body and soul have left the corpse behind.

"(d) Body is body only in so far as it is organic to soul, therefore one may be permitted to say that the connection between soul and body is more apparent at one time than another, *e. g.*, waking than sleeping, action than inaction, etc., but I see no reason for regarding this distinction as final, since *visibility* and *externality* are not the true criteria of soul activity. The only criterion is permanence.

"Souls of the dead are of size and form of body in life, not subject to gravity; capable of penetrating all matter unobstructed, and transcending all limitations of time and place. I have conceived souls as retaining sex distinctions but only in an ideal sense. Children remain children with developed intelligence, but still retaining the naïve simplicity of the child. Cultured and ignorant remain relatively so.

"Yes, as the soul is the developed form of the 'Ego,' it would naturally be different in different ages, as among different peoples and different individuals.

"In my early days of course the current theological dogmas as to rewards and punishments appealed to my imagination, though I cannot say that they ever satisfied my intellect. Now I think every soul carries into the hereafter the accumulated heritage from earth and will find its place in the further process of evolution according to its own choice and capacity. But I do not think we can judge the destiny of a soul by any time standard. Every soul is organic in a great purpose and can be judged only in reference to its service towards that end. Good and bad are largely relative to a time judgment and may have little significance relative to the real function of a soul as an organ in the world history.

"Well-doing can have meaning only in reference to environment. No soul exists apart from an environment. There is no absolute self.

"My ideal life, here and hereafter, is 'fitness for the place I occupy.' I hold this ideal in no fatalistic sense but in the conviction that man attains such perfection as is possible for him by filling well (*i. e.*, in good will) the place in which he finds himself."

Not all of the returns admitted of classification as here outlined. Most of them, strictly speaking, would fall into the theological group,—a small number might be classed as psychological and a smaller number as philosophical. But as a group, perhaps brought out by the questions, the replies all bear testimony that the writers of them have been influenced by religious training. If they may be taken as an index they show how lightly our instruction in psychology, the purpose it serves in life—compared with the vital question of theology—falls on the surface of the mental content. From the returns, the mind or the self, while they may be regarded as the equivalents of the term soul, have never commanded the thought or attention of those replying as has the soul; this can be easily observed from the language. If the psychologist desires to replace this word, unless there is a radical change in our methods of education, such an effect will not soon be changed. Current psychology has cast off the very term, the name of the very core about which it developed. A term in its early days considered so vital and so sacred that men have suffered anathema and ostracism for their adherence to opinions regarded as detrimental to society. In order that the student may understand how bitter and costly these disputes have been—what persons have suffered for daring to express an opinion, something in regard to the history of the term should be incorporated in our psychologies. We bespeak at least for modern psychology a chapter that will briefly state its history.

Many of the replies were from students engaged in the study of psychology, others, from psychologists at present teaching the subject. From the returns it would seem that soul and mind are in most cases identified, and yet like a double load they are trying to carry. The ideas are for the most part in harmony with current psychology, but when detailed explanations are required in regard to soul, they tend to fall in line with

theology. In details they do not adhere strictly to current psychology. This is no doubt due to the fact that students replying have not gone into the subject very deeply, *i. e.*, have not had sufficient time perhaps to master the text they may be using. Moreover, comparatively few students who elect the subjects of philosophy and psychology have the analytic turn of mind necessary to pursue the subjects for the pleasure derived from them long enough to thus become thorough-going psychologists.

Summary. The idea of a soul will continue to exist as long as the idea of an immortal being or substance persists.

Theology has considered soul with special reference to a personal God. It presupposes a substantial survival after death. The present theological idea of soul is largely what is meant by the totality of a man's life. The influence of the church is the greatest factor in moulding ideas in regard to the soul. Recent psychology has tended to ignore the idea although centered about this point it had its birth. It presents a hostile attitude toward the idea. Empirical psychology, dealing only with the phenomena of mind, recognizes no unifying factor but consciousness.

The teachings of the church in regard to the soul reach the thousands, while those of psychology reach the few; the masses of people believe in some soul substance. The effect of psychology is to destroy something—which may be satisfactorily explained for the psychologist, but not for the uneducated. The definition of soul by the average person would be to the effect that the substance of it, so to speak, is found in the feelings. The feelings alone recognize its substance. Modern psychology has not fully investigated the feelings.

Ideas of Materialists Regarding the Soul.

A study of the subject is not complete if materialism is not represented.

Materialistic ideas of soul, spirit or mind, represent it as a substance, usually of very fine particles, as, for example, the views of Democritus, those of the Epicureans, the Stoics, Lucretius, and those of certain modern writers. La Mettrie regarded it as a fluid passing through the nerve tubes, and Holbach could not distinguish it from the brain—thought is hidden in the movements of its fibres. For [1] Czolbe sensation is motion, resulting externally; the turning back of this motion in the brain, on itself—from all the senses—forms the unity of consciousness. For Haeckel, spirit and mind are reduced to force and are inseparably connected with the body, as much a

[1] Lange: History of Materialism.

function as every force is of a body. For Moleschott it is a product of the brain as bile is a product of the liver. For Büchner it is a property, or capacity—as the force of a steam engine inseparable from the steam. Or for others it is an ethereal substance, and it may or may not be a product of the body, as the following:

"The ether,[1] then, as it is coming to be apprehended in the new modes of thought, is an immaterial, superphysical substance, filling all space, carrying in its infinite throbbing bosom the specks of aggregated dynamic force called worlds. It embodies the ultimate spiritual principle, and represents the unity of those forces and energies from which spring, as their source, all phenomena, physical, mental, and spiritual, as they are known to man."

Or another view is that of a universal liquid of minute molecules.

"The[2] molecules are vortex rings in a liquid of still finer grain and less viscosity. Molecules, liquid, molecules, liquid, alternately forever; each term of the infinite series being fully explained by the next following." The second ether fashions the spiritual body. Our consciousness proceeds *pari passu* with molecular disturbance in our brains, this molecular disturbance agitates the first ether, which transfers a part of its energy to the second. "Thus is gradually elaborated an organism in that second or unseen universe, with whose motions our consciousness is as much connected as it is with our material bodies." The spiritual body is replete with energy at death and floats away in the unseen universe, taking consciousness with it, but leaving its molecules behind.

Another view:

"Soul[3] is the body or organ of the mind, and as such they are inseparable forever. Mind and soul are one; soul and body are two. Soul is a refined subtle essence, a spiritual body within the animal body an ultimate indecomposable, ethereal matter, something like an electric body, and as such, quite as material as rock or pig iron, and is conscious by its nature as atoms are cohesive by their nature. . . . . It grows as other matter grows, is enduring and persistent like all other elements, preserves its identity and continuity precisely as the body does, and is immortal because of more homogeneous and ultimate essence than the physiology. Repeated shocks will disintegrate and weaken the cohesion of the soul as they will the cohesion of the iron."

---

[1] Stockwell: New Modes of Thought, p. 73.
[2] Clifford: Lectures and Essays, Vol. I, pp. 282-92.
[3] Hemstreet: Mind is Matter, pp. 30-39.

It will be observed that some of the so-called materialists regard the soul as a product of the body but do not attempt to ascribe its form or assert what they think to be the nature of its substance. Others would give some theory as to its composition. The ethereal view of soul or mind substance, in the light of recent discoveries, will probably claim for itself a larger circle of adherents.

Theories Presented Regarding the Self.

The word "self" has tended to take the place of "soul" in recent psychology and philosophy. From the standpoint of philosophy, soul is supposed to be too inclusive;—if immortality is presupposed, there is the objection that it embodies certain elements not immortal, while self, more definitely an object of knowledge is immortal.

The reason why the term "self" is used in preference to that of soul, or why the meaning conveyed may not justify the use of a broader term as that of "soul," may be better understood if we cite some explantions from recent writers.

Prof. James[1] speaks of the empirical self of each person as the "me." The social self is the recognition we get from our fellow beings, the effort of living in the sight of our fellows. Truly speaking "a man has as many social selves as there are individuals who recognize him and carry an image of him in their mind."

The spiritual self is the inner or subjective being, the "psychic faculties or dispositions, taken concretely" not the principle of unity or pure ego. These psychic dispositions are the most ultimate part of the self—and also the most enduring. These are changed only when a man is *alientus a se*.

The Pure Ego is the unifying factor, in it is found the sense of personal identity. Our remoter, spiritual, material and social selves come with a glow and a warmth, in the aroused organic emotion. This warmth is either something in feeling of the thought, or else the feeling of the body's actual existence. We cannot recognize our present self without one of these. Any distant self which fulfills this condition will have the same warmth, but may be in less degree. This thread that runs through the various selves and unites them is the Ego. Resemblance among the parts of a continuum of feelings constitutes personal identity.

"Of[2] the nature and part of *consciousness* which is the true self we can obtain no direct evidence in reflection, for this true self is that to which the increment is presented, and which itself can never be presented in reflection."

But this is the self of consciousness with which the metaphysician deals. It is that part that is sought for analysis, and is only an inference *ad infinitum*. Mr. Marshall concludes in his article by pointing out that the self *in toto* "speaks of the experience of all our ancestors, of those who were men and of man's long line of progenitors of diverse animal forms." "This self says to us 'The elements which are present in the fields of attentive consciousness represent but a paltry array

---

[1] Principles of Psychology, Vol. I, p. 294 *seq.*
[2] Marshall: Instinct and Reason, pp. 107-112.

of experimental effects." This sub-ancestral influence "is not differentiated by the excessive or emphatic partial activity of any part of the complex system; it is the mass of 'feeling' so called by many; it is that part of the moment's conscious experience which we are warranted in describing as the field of inattention." So the true self must "be allied with the presented 'instinct feelings' rather than with variant reason."

From the standpoint of a purely ideal system we may notice Prof. Howisson's[1] views. He does not deal with "self" perhaps so much as "mind." In fact objection might be raised as to the justification of classifying his analysis under a study of "self." He assumes that "All existence is either (1) the existence of minds, or (2) the existence of the items and order of their experience; all the existences known as material consisting in certain of these experiences, with an order organized by the self-active forms of consciousness that in their unity constitute the substantial being of a mind, in distinction from its phenomenal life."

These many minds are the determining ground of all events and 'mere' things, and form the eternal world, which he calls the "City of God." God the fulfilled Type of every mind, the living bond of their union reigns in it, by being the impersonated ideal of every mind. The members of this eternal Republic have no origin but a logical one with reference to each other, including their primary reference to God,—in the literal sense no origin in time. There is nothing prior to them out of which their being arises, but they simply are and constitute the eternal order. They are free since they are the source of all the law of this realm. This pluralism of minds is the "mover" of all things. The world of spirits constitutes a circuit of moral relationships, and its union is found in God. God has no being subject to time, nor is the fundamental relation of minds to him a temporal relation, and "creation must simply mean the eternal fact that God is a complete moral agent, that his essence is just a perfect conscience." The key to his system he says "is fixed in its doctrine concerning the system of causation." Efficient cause is reduced and final cause is substituted in its stead, *i. e.*, God is not the end but the guiding, regulative and constitutive principle of real existence.

Another view[2] endeavoring to establish the immortality of the self is that set forth by Prof. Schiller. He notes that the self as it appears is the phenomenal self and the self as the ultimate reality, the transcendental self. The phenomenal self is that part of us that changes with the flow of consciousness, the change of personalities; a knowledge of which is gained by experience and experiment, and an examination of the flow of consciousness. It is not separated from the Ego but this is the unifying part. The phenomenal self represents but a small part of the individual at any time, but the Trans-Ego is the "I" with all its powers and latent capacities of development. The self approximates in its development more and more to the Ego.

The ego is both the basis and end of development within which the selves alone are real. Pre-existence of the soul is not an illusion, it explains the reincarnations of Buddhism. The soul of man has been developed from the souls of animals through a process of evolution.

Bradley recognizes the self as follows:

[3]"The self and the world are elements, each separated in, and each contained by, experience. The self is, and likewise the soul is, an intellectual construction based on immediate experience, yet transcend-

[1] The Limits of Evolution.
[2] The Riddle and the Sphinx.
[3] Appearance and Reality, p. 525.

ing it. The self is one of the results gained by transcending the first imperfect form of experience. Experience in the early form is not yet self or not-self. Its unity gives way before inner unrest and outer impact in one."

And then self and Ego, on one side are produced by this development, and on the other side appear other selves and the world and God. These are the contents of our experience, but our experience is part of the universe. So there is no stepping over the line from one world to another. Experience is in both worlds.

For Dr. Royce:

"Self[1] is just your own present imperfectly expressed pulsation of meaning and purpose—this striving, this love, this hate, this hope, this fear,—this inquiry, this inner speech of the instant's will, this thought, this deed, this desire,—in brief this idea taken as an Internal meaning." Self is an ethical category in the sense that one selects from all the Universe a certain portion of remembered and expected life as that of his own, in contact with other selves the large individuality and the life of the Absolute. By the contrast with the not-self I am as sure of myself as of Being; our individuality is expressed by mutually contrasting our life plans, "each reaches its own fulfillment by recognizing other life plans as different from its own." "In the present form of human consciousness self is an ideal, its true place is in the eternal world, where all plans are fulfilled, it derives everything from others except its Uniqueness, God's will is consciously expressed in this."

What can we say from these definitions of self?

It is an analytic explanation, not of the present feelings but of their objectification. The word "self" is more definite than "soul;" it has no uncertain history; it is subject to analysis. We identify and know ourself. By soul we mean both the "ego" and the "me,"—the subject and the object are both included in the soul. The preference for the word self is in line with certain tendencies of thought noted in this paper, *i. e.*, a gradual tendency toward definiteness. Comparisons with the crude undifferentiated ideas of the savage, or with the less definite ideas of soul expressed during the middle ages, show a line of progress that approaches exactness and definition of idea. The "self" has arisen as a result of careful analysis. It has its place in psychology, and any study of the subject would be incomplete without it. If American psychology follows along the lines of the old English school, or if it adheres strictly to an empirical basis, then, with Bacon, "soul" may be relegated to theology. To-day we recognize various aspects of psychology, and among those the psychology of religion. The subject is not one that stands aloof from others. Since it is a study of mind and psychic phenomena in general the psychologist is brought face to face with the soul of theology and he must recognize the significance of the term and its meaning with reference to psychic life as a whole.

As has been often mentioned psychology and philosophy are often harmful to the spiritual life of the student. That one line of study should be destructive to the teachings of another, if they are both for the welfare of the the student, is not good pedagogy. The attempt of psychologists to place the subject on a scientific basis has tended to make it assume a hostile attitude. The feelings, because they are not subject to analysis, have not been given a place commensurate with the extent they influence action. A large part of what people call the "soul" is included under the term feelings. The contest is between

[1] The World and The Individual, Vol. II, pp. 272-89.

the two types of mind, the cognitive and the affective, or between cognition and feeling in the same mind; the one relating and classifying, dealing with the world of thoughts; the other acting on that cumulative heritage, the feelings. The analytic self is based more on the present objective side of consciousness, the soul includes both the subjective and objective.

Localization.

Any study of the soul-idea cannot well omit some mention of the ideas that various writers have expressed as to the part of the body in which the soul is located. The savage expresses his opinion as to where it is located, civilized man expresses his. Certain lines of progress have been made. The main line of progress keeping pace with the advancement of civilization, is the tendency to recognize the head or brain as the central organ in which the soul is located. *Pari passu* with this movement is a gradual change from the identity of soul as a life principle to the notion that it is mind. The material for this section is based very largely on a similar study by Volkmann.[1]

The idea prevailed among some of the ancients that the soul was mere vital power, as such, the blood, filling the whole body was its seat. This idea existed among the ancient Hebrews, and as a result of this they prohibited the use of blood. Psychic functions were not ascribed to the blood but to the heart, and the feelings originated from the intestines, bones, liver, gall and kidneys. The records of the Hebrews after the exile show that they located the soul in the head. References for this may be noted in Daniel;[2] contrary views, however, are also expressed. Among the Hindoos the most significant part of the soul is connected with the heart. It has been observed that localizing the soul in the head above the seat of sensuous pleasure and desire is the first step toward the thought of its immortality. Besides the part in the head most barbarous or semi-civilized peoples recognizing the soul as being complex locate other parts of the same in different organs of the body. The Persians[3] localize anger in the head, thought in the heart, and sensuous desire in the liver. The oldest reports concerning the brain as the seat of the soul point unanimously to Egypt; here the belief in immortality and transmigration was long prevalent. From Egypt Pythagoras is reported to have carried the idea into Greece. The Pythagoreans located the *nous*, or rational soul in the brain, life and sensation in the heart, seed and germination in the navel, generation in the sexual parts. According to Philolaus[4] the first of these contains the germ of men, the second of beasts, the third that of plants, the fourth that of all creatures. Alcmaeon is given the credit of having first taught that all sense organs are connected with the brain. By some he is considered the founder of the doctrine of immortality. Democritus held views similar to those of the Pythagoreans, *viz.*: that the thinking part of the soul is located in the brain, anger in the heart, sensuous desire in the liver, but the soul is extended throughout the body. Plato located the *nous* in the head, the *dumos*, passion, in the breast, the *epidumetikon*, sensuous desire, in the abdomen, the parts being distinctly bounded. The influence of certain organs which may from some cause demand undue attention tending to change the course of the individual thought, or attention to them is an important factor determining localization. This may have been due to some individual trait or tendency of the

---

[1] Lehrbuch der Psychologie, Vol. I, pp. 80-90.
[2] Chap. II, 28, IV, 5, 11, 30.
[3] Delitzsch: A System of Biblical Psychology, p. 298.
[4] Ziller: Pre-Socratic Phil., Vol. I, p. 480.

writer or teacher or to some pathological condition, thus giving undue predominance to some organs. Aristotle opposed the separation of the soul as made by Plato. For him the perceiving and nourishing parts in man, and animals having a heart and circulating system are located in the heart. In the case of those animals having no such system, the soul is located in that part exercising the function of the heart. In plants and in animals that manifest life after being cut to pieces each part may be the seat of the soul, or at least they have that possibility. The principle of motion, sensation and nourishment must be located in a middle point of the body where the exchange of blood takes place. The brain cannot be the seat of sensation because on immediate contact it is painless, it is the foulest, dampest part of the body, as opposed to the heart streaming with fire-colored blood. The Epicureans located the rational part of the soul in the heart or lungs, while the irrational was thought to be diffused throughout the whole body. Herophilas of Alexander and Galen, under Platonic influence, and also under the influence of Hippokrates, permanently located the thinking part of the soul in the brain; this they also recognized as the organ of memory. Galen ascribed to the lower soul part, that in the rump, the preparation of vital spirits. Xenocrates located the rational soul in the crown of the head, Strato in the middle of the forehead between the eyebrows. In the change of position in localization of the soul, its gradual transference to the head, can be noted the change of the idea of the soul to that of a something having to do with the mind, and in fact a gradual identification of it with the mental processes. Neo-platonic doctrine located the soul in the whole body,—entirely in each part of the same. Nemesius—following the psychology of Aristotle, locates the soul as coincident with the body, placing phantasie in the anterior, memory in the posterior, and intellect in the middle ventricle of the brain.

Gregory of Nyssa, and St. Augustine prefer a symmetrical division of the vital soul throughout the whole body; Gregory opposes locating it either in the brain or heart, while Augustine recognizes the heart as the central point of the corporeal life and involuntary motion, the brain as the central organ of sensation and voluntary motion, sensation originates in the anterior, motion in the posterior, and remembrance in the middle part of the brain.

Thomas Aquinas located different activities of the thinking soul in different parts of the brain. His doctrine of location practically overthrew the Aristotelian view of the heart as the seat of the soul. The nervous system has begun to be an object of study. Cossman opposed the ancient location of the soul from the standpoint of nervous anatomy, and recognized the brain as the common sensorium of external sense as well as the immediate organ of inner sense. With Descartes the conception of the soul as a unity, opposed to the body, excluded the idea of its being separated. From his mechanical conception of the body, and his knowledge of the nervous system, he reasoned that there must be some central point, undivided, from which the motive forces of the body originate. Thus the pineal gland, as a single organ, was selected. Lancisi and Bonnet[1] located the soul in the corpus callosum, Digby in the transparent septum, Haller in the pons, Boerhave in the prolonged cord, Plattner in the corpora quadrigemini. Sommering made one of the last attempts in this direction, but he avoided the older theories of glands and certain brain parts, and pointed to the fluid in the brain ventricles—as the water over which the spirit floats or is suspended.

Leibnitz did not consider the soul to be located at any one point in

[1] Volkmann. Lehrbuch der Psychologie, Vol. I, p. 88.

the body, but thought it spread out through all the cells; Bumgartner followed out the same idea, and claimed that the soul has no place, not even in space, but that its identity is preserved through its relation to the other monads. Since the time of Kant the question has fallen into more or less discredit. In his earlier writings Kant granted that in the mind of a visionary or enthusiast there are ideas of a spiritual substance which occupy space, but do not fill it. In his later works he corrects this view. The futility of physiological attempts on the one hand, and the attention given to the dynamic conception on the other, are favorable to the idea of the whole body as the seat of the soul, with the nervous system instead of the blood as the basis. J. Müller,[1] from a study of the localization of the senses and also from studies of parts of dismembered organisms that continue to live, concluded that the soul is co-extensive with the body, but the brain the fundamental organ. Most of the school of the philosophy of identity took this view. For Fischer the unconscious soul has its seat in the organon, outside of the nervous system, the conscious soul in the entire nervous system, and in the brain as the central point in so far as the latter, as a central point, outweighs the other parts of the system. Fichte held similar ideas; in a wide sense the whole body is the organ of the soul, in a narrow sense the nervous system, for the soul is everywhere that it operates, with this modification, that definite parts of the nervous system determine definite functions of the soul, as for example one function of the hemispheres is consciousness. For Schopenhauer the whole organism is the objectification of the will, the brain that of the intellect. For the Hegelian school the category of space can have no significance for soul as subjective spirit, it is lost through the whole organism, everywhere centre and everywhere periphery. It is outside of space, and not a mathematical point. What is in the brain is at no time soul, for the soul is only subject. "The soul is everywhere and at all times for I wander with thought through all ages and through the whole universe" (Eschenmayer). Ennemoser found in the whole question as to the localization of the soul an interesting chapter in human foolishness.

Fortlage placed the question beside that of the old question of locating the earth in the centre of the universe or that of reducing things to the simplicity of the four elements. The localization of the soul as a whole, or at least the rational part of it has passed over into the question of localization of function of the cortex. Phrenology gave this a great impetus, and every disproof of the crudeness and worthlessness of phrenology led to a more thorough and exact study of the brain. Lange[2] observes that "Instead of one soul phrenology gives us nearly forty, each in itself as mysterious as the life of the soul is generally. Instead of resolving it into real elements it resolves it into personal beings of various character. Men and animals, etc., most complicated of machines are the most familiar to us. We forget that there is something to be explained in them, or we only find the matter clear when we can imagine everywhere little men over again, who are the bearers of the entire activity."

Huschke[3] taught that to the medulla oblongata, and to the cerebrum belong willing, to the parietal lobes feeling, and to the frontal lobes thinking. Carus found the original seat of the soul in the corpora quadrigemini, but there is a three-fold division of mind.

Lotze[4] considered bodily affections necessary for the soul, as these

---

[1] Volkmann Lehrbuch der Psychologie, Vol. I, p. 89.
[2] History of Materialism, Vol. III, p. 124.
[3] *Ibid* p. 134
[4] Medicin Psychologie, Chap. III.

are converted into sensations and elaborated through its own action. Nerve fibres are necessary for some of the processes of the soul, for other processes organs are needed, and for some neither nerve fibres nor organ is necessary. The soul is probably located in that part of the brain where there are no fibres, because there is no central point where all the fibres meet.

For Fechner, in a wider sense, the soul is located in the entire body, in the narrower sense (that of consciousness), in a part of the nervous system; this part, as we descend the scale of the animal kingdom, increases in extent or becomes more generalized.

One of the last theories of localization is that of Pflüger.[1] By means of his well known experiment he attributed a soul to the spinal cord of the frog, lizard, etc. His method was as follows: A decapitated frog is smeared on the back with acid, it wipes the drop away with the most convenient foot; if this foot is now cut off at the thigh, and more acid placed on the same spot, after some unsuccessful attempts with the stump, it will complete the movement with the opposite foot. This process of changing he thought indicates reflection. Within itself it is no mere reflex act, so he predicated the spinal soul. To disprove the theory Goltz placed two frogs, a decapitated one and another in perfect condition in water. This is gradually raised to the boiling point. The decapitated frog makes no effort to escape, the normal one struggles to free itself. From this Goltz concludes that there is no soul in the cord.

The experimenters in these cases are not dealing with the "soul" of the middle ages, but something akin to consciousness. So with all the later ideas of localization, it is rather one of function, *i. e.*, determining precisely what a certain organ means, or contributes toward motivising the organism or to its welfare, rather than fitting a functioning, and perhaps immortal, soul on some organ. Bosanquet[2] speaks of the soul thus: "Probably most of us at one time thought that *mind* is a *thing* which thinks and seems to move the body with which it is co-extensive—without any assignable mechanism. As we begin to be educated we find out, *e. g.*, that mind is not present at the tips of the fingers where we seem to feel; that the actual skin and flesh is not sensitive, but only the nerve upon pressure of which feeling follows. A further stage of the same discovery is when he learns that if a nerve is cut anywhere between finger and brain there will not be any sensation in the finger, so that really the feeling at the finger tips is not a mistake but an illusion. Then must all remember when we found out—what Mill points out—that the will is not magical, that, *e. g.*, a numbed arm will not move. That is, the sequence of movement upon will is not infallible, is not magical, but depends upon a certain mechanism that may go wrong; we do not know whether it will really act except by trying. Experience of this kind make us withdraw the magical notion of the will from the outlying parts of the body, until in popular culture, we get a sort of idea of the soul as a little creature sitting in the brain."

This sketch shows that certain substitutions have been made in the idea of localization. An empirical mind derived largely from the senses has taken the place of the dim, mystical, idea, which was a combination of life and soul, vitality and mind, held by the ancients. This has its basis in the functioning of a normal nervous system, instead of the blood, some organ connected with circulation or digestion. The change of idea has been gradual, and has been made only with the development of science. Modern psychology recognizes the brain

---

[1] Goltz Die Functionen der Nerven-Centren des Frosches, p. 110 ff

[2] Psychology of the Moral Self, pp. 115-125

as the organ of cognition, but the feelings and emotions are not definitely located.

In concluding this study of the soul, however barren and fruitless it may be as to exact definition, yet it is not without some results. However analytic the psychologist may be he is still hopeful, optimistic and charitable in his beliefs. Prof. James grants that the mind is immortal. Prof. Royce recognizes as immortality of the soul the survival of one's "purpose" in life, or of a certain "internal meaning." The subject matter of neither psychology nor philosophy has yet been fully adjusted to the theory of evolution. It is probable that when these are worked out on the basis of development a constructive attitude will be taken. Instead of deriving "soul" by a process of analysis the elements from which it has developed will be pointed out. It may be that the traits of character exhibited by the various species of animals are the elements from which the soul of man has evolved. Analysis alone will never fully explain what is meant. By soul the mass of people have in mind, besides the thoughts that may have aroused them, the waves of feeling that rise in them when they think of certain experiences. The feelings are the common heritage of the race, and the fact that we share a common feeling makes society possible. The soul of religion, psychology, and philosophy should be one, representing as they do two sides of the same phenomenon. While philosophy presents the cognitive side to us theology presents the side of feeling.

It is poor pedagogy to present to the student ideas along one line of thought that are destructive to a related system of ideas. Educators who have to deal with elementary and secondary education have striven to correlate different studies, that certain ones may be contributory to others, and that they may make for the harmonious development of the pupil. This principle holds true none the less for studies beyond the period of secondary education. The order in which the subject matter of philosophy is presented often does the student more harm than good. Theology and philosophy should be in harmony; the ideas of the soul derived from psychology, while they should be exhaustive, should contribute to the teachings of theology. The idea of the soul will continue as long as people desire survival after death. Our study of the subject leads to the following definitions: for educated thoughtful people the soul probably represents an ethical ideal. in a general way this may be embodied in certain principles, while the majority of Christian people refer to an undefinable mass of feelings.

FACIAL VISION: A SUPPLEMENTARY REPORT, WITH CRITICISMS.

By Professor Robert MacDougall, New York University.

In the fifth volume of *The American Journal of Psychology* Mr. F. B. Dresslar reported an investigation of a phenomenon to which the name "Facial Vision" has been given. This is the capacity to perceive the presence, and with more or less exactness to discriminate the character, of objects in proximity to the blindfolded subject. The faculty is commonly remarked in the blind, and has also been observed among persons possessing sight.

The surmise had been made by Professor James that the perception of such objects might be based upon sensations of pressure on the drum of the ear, due to changes in the movements of the air caused by the presence of the objects in question. Mr. Dresslar's experiments were first directed to this point, and after a series of tests, which seem to have been protected from all invalidating error, the conclusion was reached that the pressure sense of the ear-drum was altogether too obtuse to be considered as a factor in the phenomenon to be explained.

There remained several forms of sensory stimulation to which the presence of objects near the face might give rise, and to the analysis of these attention was next turned. Every large object by which one passes modifies the movements of the air, cutting off the wind on the one side and causing eddies and back-draughts on the other, thereby affecting the sensations of pressure on cheek and brow. It likewise disturbs the local distribution of heat by intercepting the cooling breeze and by absorbing and reflecting the rays of the sun; and by also preventing the free radiation of heat from the body it may give rise to discriminable differences in temperature sensation. Such an object, finally, disturbs the free propagation of sound-waves, intercepting and reducing those coming from the one direction and reinforcing by reflection those which come from the other side.

Any one of these factors severally, or a combination of them, may conceivably afford the sensational basis upon which the reported perception depends. The first two of these aspects are difficult to separate, since the organ of sense in each case is the spread-out surface of the skin. The third element, that of

sound, may readily be isolated, and it is with its function that the experiments in question are chiefly concerned.

Four frames of wood one foot square were prepared, one of which was filled in solidly, the second latticed with strips three-quarters of an inch in width with intervening spaces half an inch wide, the third covered with wire netting, and the fourth left open. These frames were arranged so that any one could be brought noiselessly to a position three inches from the face of the blindfolded observer, as he sat in a chair. The series of frames was grouped in pairs,—Solid-Wire, Lattice-Open, Solid-Lattice,—so that discrimination was limited to choice between two objects, and was thus both simplified and given definite direction.

With three observers having normal senses experiments with these combinations gave respectively 94, 68 and 90 per cent. of correct responses. Thus the ordinary person seems to have a perception of the proximity of such objects involving a fairly high and reliable discrimination of their detailed features. The observer was then seated with his side to the apparatus, and a screen was interposed between his head and the frames, in the centre of which, and opposite to the passage of the ear, a small hole was pierced. Changes in temperature and pressure sensation due to differences in the filling of the frames were thus practically shut out, yet when the experiments were repeated under these conditions no diminution in the number of correct responses appeared, the percentages being respectively 91, 80 and 93. The figures show an actual increase in discriminative power. Finally the ears were stopped with cotton and the frame presented as in the first set of tests. The preponderance of correct responses, upon which the evidence of a process of perception rests, then entirely disappeared, the percentages being now 53, 51 and 49 respectively. The evident conclusions are that a real process of perception is involved, that it depends upon sensations mediated by the ear, and that these are strictly auditory stimulations of the nature of slight changes in the character and intensity of the confused mass of faint sounds falling upon the ear from moment to moment.

These results show a very high degree of certainty in the responses under conditions where factors of disturbance would naturally be supposed to occasion a large variable error. Correct discrimination rises to above 90 per cent. of the total judgments, even between those objects of the series whose capacities to interrupt radiation and air-currents are most nearly equal. In the discrimination of double contacts upon the skin there appears a region of confused perception, the threshold of which is commonly defined to be that distance which gives rise to 75 per cent. of correct responses. That the material upon

which discrimination proceeds is present in the region immediately below this threshold appears from the preponderance there also of correct responses; but its features are submerged in the mass of subjective and objective variations to which the observer is exposed from moment to moment. By increasing the separation of the points a distance is reached at which the influence of the differential increment becomes clearly greater than that of such disturbing factors; and the valuation of the threshold, —at, say, 75 per cent.,—means simply the agreement upon a proportion between correct and incorrect responses which shall represent a satisfactory margin of preponderance in the constant over the fluctuating differences.

In the experiments now commented upon almost the whole series, exclusive of those with closed ears, gave results which lie above the threshold as thus defined. This is a surprising keenness of perception to be based upon such sensational material. The forms of sensibility upon which discrimination in such cases depends are apparently, in many instances, highly developed in the blind, and no doubt enter as factors into the total complex upon which the reactions of the normal individual are commonly based; but that they are not isolable elements, which can be identified as independent sources of perception, is shown not only by the experience of ordinary life, but also by the fact that under the special conditions of these experiments, in which attention was directed purposely to their analysis, the observers were unable to indicate any single specific sensory change upon which discrimination depended. The personal reports of the observers clearly show their hesitation in assigning the sensations by which the perceptions were mediated, for each enumerates several factors which "perhaps," or "sometimes" were, or "seemed to be" present. In two features all three observers agree, namely, in the impression that temperature changes and a "shut-in" feeling were to be noted, but one only unhesitatingly indicates variations in the auditory content as the basis of perception. But if the ear afforded the means of such exact discrimination as appears in these tables, —nine out of ten responses being correct, roughly speaking,— it is surprising that a clearer identification of the nature of the sensory impression was not made by those who took part in the investigation.

It is, I think, a fair conclusion that judgments based upon auditory material of this kind, too confused and weak to be clearly recognized, should be expected to fall in the subliminal rather than in the supraliminal region. In other words, the proportion of correct responses should be between 50 and 75 per cent., between the indifference point of guessing and the threshold of reliable discrimination.

It may seem an inversion of the natural order of criticism to challenge the high degree of accuracy presented by the reactions of Mr. Dresslar's subjects, since such judgments do, of course, shift from guesswork to unvarying correctness according as the values of the constant and variable factors vary. Nevertheless though such a percentage might well reflect perception based upon a group of co-operating sense data of different orders, no one element of which could be readily isolated, it seems too high to be justifiable on the sole basis of such an auditory factor as is described in the report. It is the interpretation of the sensory sources, not the proportion of correct responses, to which my criticism is directed. Notwithstanding the apparent conclusiveness of the final test, *i. e.*, with the stopped ears, I am convinced that throughout Mr. Dresslar's experiments other than auditory factors were significant, and that the method of excluding the latter involved concomitant changes which interfered with the process of perception at large. The curious distribution of sensory types in the two investigations is sufficient to arouse suspicion of this kind, for it is improbable that in the one should be fortuitously gathered three observers of exclusively auditory type, while the reports of all those in the other indicate the presence of additional sensory values, though not to the elimination of the sound factor itself.

In view of several considerations the present writer made a substantial repetition of Mr. Dresslar's experiments, the only difference to be noted being the substitution of the combination Solid-Open for that of Solid-Wire, which gives a slightly wider range of objective differences than were incorporated in the original investigation. Apparatus and signals were controlled from a distance (yet within the same room), and responses were given by pressure upon an electric key. Three persons took part in the investigation, all of whom had had previous training in laboratory research. Thirty judgments of the several combinations were made under each experimental variation, the members of the pairs being presented an equal number of times in every series of tests. The total number of judgments thus lay between two and three thousand.

The results confirm Mr. Dresslar's conclusions that the person of normal sensory condition and without special training is sufficiently affected by such stimulus variations as are here in question to be able, independently of the sense of sight, to detect the proximity of the various frames, and in some degree to discriminate their individual differences. The observers who took part in the investigation were of various grades of sensibility, their correct responses under all conditions bearing the following mutual ratios: A, 1.00; B, 0.91; C, 0.85.

In the case of even the most obtuse observer, however, a clear margin of positive discrimination appears, so that there is no reason to doubt the presence of a true perceptual process, based on (at least) subliminal differences in sensation.

The distracting influences noticed in the course of the work were of two types, tactual and auditory. In the early part of the investigation visual perception was eliminated by lightly bandaging the observer's eyes. The presence of this girdle being complained of, the blinds of the dark-room in which the experiments were carried on were closely drawn and the bandage removed, the observer also closing his eyes during the course of the test. The result of this change was to increase the number of correct responses from 62.3 to 71.0 per cent., all observers and experimental conditions included. Further, at the beginning of the investigation, which was carried on during the months of May and June, the windows of the room were kept partly open, in consequence of which the sounds arising from breathing movements, etc., were augmented many fold by the noises of the street near by. This also was found a serious distraction, to remedy which, first, the window was closed, and secondly, the tests were later made at midnight when streets and building were deserted. The proportion of correct responses underwent corresponding changes, as follows: Day, window open, 58.3%. Day, window closed, 62.3%. Midnight, 71.0%. Concerning these concomitant variations, which in themselves afford further evidence of the presence of a perceptual process, it is to be observed that there are two separate bearings which such changes in the physical surroundings may have upon the latter process. One is the distracting influence already spoken of, which the presence of the auditory or tactual stimuli exerts upon the attention; the other consists in possible modifications of the stimulation or of the sense organ upon which the perceptual process depends. In addition to its distracting influence the bandage about the temples interferes with the normal radiation of heat from the skin and reduces the sensitive surface exposed to stimulation by changes in the temperature or movements in the air immediately surrounding the body. The street noises, likewise, both disturb attention and modify the character and violence of the stimulation falling upon the ear. But it is also to be remarked, in considering the points of difference between this and the preceding investigation, that while in the case of the bandage the two sets of influences clearly work together, that which increases the sensory area at the same time reducing the distraction, in the case of auditory disturbances there is no such evident correlation. On the contrary, a result of the opposite character is to be expected, since the absolute differences

in stimulation caused by the introduction of an object which more or less shields the ear from impinging sound-waves must be greatest when the volume of stimulation is itself at a maximum. Since, therefore, the changes are of the same sign in both cases, and the greater increase takes place in connection with the reduction of auditory disturbances, the influence which these factors exert is to be attributed to mental distraction and not to their immediate sensory values.

The proportion of correct responses obtained from the present set of observers differs largely from those reported in the original investigation. The individual averages for all conditions tested are severally as follows: A, 54.7; B, 58.3; C, 64.0 per cent. Individual extremes for single sets of conditions range from 54.3 to 73.0 per cent. of correct responses. These proportions lie wholly within the limits which, on the whole, as was pointed out in the earlier part of this paper, are to be expected from the nature of the conditions under which perception works.

A second point to which attention may be called in connection with this investigation is the relation of the proportion of correct responses to the magnitude of the differences existing between the objects to be discriminated. The applicability of the method of right and wrong cases depends upon the fact that if the phenomenon involves a true process of perception the percentage of correct responses under any given set of conditions should be a correlate of the series of differential increments presented by the sensational material upon which it is based. The absence of such a concomitant variation indicates either guesswork or a source of knowledge independent of the sensory process.

The series of objective differences in the materials employed in the present investigation are, in order of increasing magnitude, as follows: Lattice-Open, Solid-Lattice, Solid-Open. The corresponding proportions of correct responses are, in the same order: 59.0; 62.0; 65.2 per cent. The number of correct responses varies concomitantly with the magnitude of the sensational differences to be discriminated, as it must necessarily do in any extended series in which a true perceptional process is involved. That this general average does not result from the fusion of inconsistent types of change may be seen from a comparison of the individual averages upon which it is based. These are for the three observers respectively: A., 52.3%; 56.7%; 62.3%; B., 59.9%; 59.7%; 62.3%; C., 63.0%; 67.0%; 70.3%. Thus throughout practically the whole set of judgments the proportion of correct responses reflects the series of differences presented by the objects to be discriminated, affording conclusive evidence that a true perceptual process is

involved in the phenomena. It is to be noted that though the percentage of correct responses made when a partial interruption of any sensory stimulus occurs must lie between the extremes presented by complete interference on the one hand and the absence of any reducing agent, yet in the case of sound at least there is not a quantitative proportion between the amount of physical interference and the intensity of the resulting sensation. To cover one half of the aperture, for example, does not reduce the loudness of the sound by the same amount. Re-arranging his differences in view of this fact Mr. Dresslar's results also present the above evidence of a true factor of perception.

No such essential dependence upon auditory processes as appears in Mr. Dresslar's results were found in the experiments here reported. The only departure from the conditions of the original investigation consisted in the substitution of conical plugs of soft rubber for those of cotton wool, on account of their greater impermeability to sound. The average for all observers under the three experimental conditions are as follows: Frontal, ears open, 65.7%; Frontal, ears closed, 62.3%; lateral, facial sensibility excluded, 56.7%. The highest proportion of correct responses occurs when all the normal avenues of sense are open: the lowest, unlike the results previously reported, appears when stimulation of hearing alone is permitted. The latter discrepancy, however, is of secondary importance, since it can be speculatively resolved into factors of imperfect control, etc.

The feature which cannot thus be reconciled is the fact that the plugging of the ears was followed by a decrease of only 2.4 per cent. in the correct responses made. In other words, for this particular set of observers the shutting off of auditory stimulation left the capacity to make such discriminations practically untouched. It is to be remembered in this connection that the mode of excluding auditory impressions inevitably introduced a serious factor of disturbance in the novel and unpleasant sensations due to the presence of the plug in the meatus of the ear, a factor which alone is sufficient to account for the falling off which appears in discrimination under these conditions. It seems necessary, therefore, to revise the conclusions of the previous report by recognizing that their application must be limited to such persons as conform to the special type of sensibility presented by those who took part in that investigation.

The small number of correct responses which were made in the present investigation when facial sensibility was excluded and auditory stimulation alone relied on, does not necessarily indicate that the ear plays no part,—or even, in individual

cases, a small part,—in the process of discrimination. The arrangements for this test were such that slight uncontrollable variations in the experimental conditions might conceivably interfere to a serious extent with the changes in stimulation caused by the different objects, and thus reduce the proportion of correct responses. All observers did not present the same curve in this regard; in two, discrimination was at its minimum during auditory stimulation, while in the third it was at its maximum, as follows (results being given in the order: frontal, ears open; frontal, ears closed; lateral, facial sensibility excluded): A., 56.7%; 54.3%; 58.3%; B., 62.4%; 63.0%; 56.7%; C., 73.0%; 68.6%; 55.0%. Further, Observer B., one of the former group, made the highest percentage attained in the course of the investigation during a supplementary experiment in which a large megaphone of stiff paper rolled into a cone was arranged with its apex inserted in the ear passage and its mouth brought within a couple of inches of the suspended frames. Under these conditions 80.0 per cent. of the responses were correct in a total of ninety judgments.

It thus appears that the process in question is not restricted to any one type of sensory stimulation, but may depend in different individuals, upon any one of several such sources, and in ordinary cases probably involves a combination of these. That to which, in addition to hearing, I should call attention, as likely to play an important part in the process, is the sense of temperature. The interference with the normal radiation of heat caused by solid objects in proximity to the skin results in changes of temperature at its surface that are by no means small, and I am inclined to believe that if a delicate thermometer were employed to test their fluctuations the latter would be found to parallel the variations in the proportion of correct and incorrect responses according as the object was made to approach or recede from the skin.

NOTE. Since submitting this manuscript I have been informed by the Director of the psychological laboratory at Clark University that through an imperfection in the report a misinterpretation has arisen in regard to two points of the original investigation. These are that the interspaces were of equal width with the strips in the lattice, and that no experiments were made with the screen in front of the face, it being at the side of the head in all three series.


A
B
C
D
E
F
G
H
I

EXPERIMENTAL STUDIES IN MENTAL DEFICIENCY: THREE CASES OF IMBECILITY (MONGOLIAN) AND SIX CASES OF FEEBLE-MINDEDNESS.

By F. KUHLMANN,
Fellow in Psychology, Clark University.

I. INTRODUCTORY.

There is one great need that every reader in this subject, I think, feels; that of accurate descriptive terminology. Many attempts, indeed, have been made to devise a satisfactory classification of all grades and kinds of cases of arrested development and thus arrive at an accurate and uniform terminology that would be really descriptive. It is singular that we have not come nearer to a solution of this difficulty than we have. We have a variety of different classifications, based upon different principles, and combinations of principles, and not one of them is uniformly followed by many writers. The division into idiots, imbeciles, and feeble-minded, according to the *degree* of general development, is perhaps the most common. And yet, even at present any one of these terms is applied as descriptive of all degrees. This mode of procedure is most unfortunate. It has made chaos of much of the literature. For, as a rule, no, or very little general description is given of the cases, so that the reader can form no idea of what sort of a case the writer is dealing with. Particular statements then in regard to his memory, attention, association, and what not, convey but little information, and meet with various contradictions, because they do not hold true of all degrees of defects. After some considerable reading, and a little first hand experience with this class of defectives, I am not convinced that an accurate classification, based upon the degree of general development, is not possible. In fact, I believe that it is, and that the experienced hand can make a further division into low, middle, and high grade idiots, imbeciles, and feeble-minded, without any serious blunders in the actual classification of cases. At any rate, such a classification is extremely desirable when it comes to a comparison of results from different cases. It is the only means to accuracy. The objection to this demand, that it is superfluous, in that when we have the results, the observations on a case, these will themselves show to what grade he belongs,

is largely theoretical only. In actually working with a case and becoming thoroughly acquainted with him we learn much more about him than our recorded results will show. We make our judgments unconsciously, from a mass of data that we lose through not getting it recorded. Thus it becomes comparatively easy to classify a case from first hand evidence, hard though it may be from mere description.

The sources from which our information of the characteristics of children arrested in development has been gathered have been various. In the older literature 'interesting stories,' accounts given by relatives and friends of the case, accounts gathered by courts, when the subject came into conflict with the law, have been pressed into service as trustworthy observations. Another distinct source of information has been the observations gathered by physicians from parents and relatives, when the case was sent to a special institution for training.[1] But by far the larger portion of the literature is based upon general observations made by physicians and instructors on a large number of cases in these special institutions. These methods have been supplemented by a procedure approaching the experimental. A few men have worked out question schema, answers to which would give information concerning the case's early life, his relatives, his early school training, as well as questions directed to the determination of his memory, his general stock of knowledge, his general intellectual capacity, etc. Seguin and Voisin have each worked out a set of 'analytical questions.'[2] Sommer has constructed a more general 'Frage-Bogen' intended for use in the diagnosis of different forms of insanity and arrested development.[3] Möller has done the same on a more extensive scale in a question schema intended only for the latter class of defectives.[4] He claims it to be the here-to-fore needed special method for the determination of the different grades of defectives. Sioli has also constructed one, based on Sommer's, but much more extended, and intended only for cases of arrested development.[5] Finally, a few experiments have been made.[6] These ways of procedure, for most of them hardly merit the name of method, need perhaps no special criticism. Whatever method gives us the in-

[1] Most institutions require application blanks to be filled out, giving answers to questions directed mainly to the history and nature of the case.

[2] Given by Sollier: Psychologie de L'Idiot et de L'Imbecile. Paris, 1891, p. 21.

[3] Sommer: Lehrbuch der psychopathologischen Untersuchs-Methoden. Wein. 1899.

[4] Möller: Ueber Intelligenz-Prüfungen. Berlin, 1897.

[5] Allg. Zeitschr. f. Psychiat., 1900, p. 113.

[6] See Appendix and Bibliography below.

formation we want, and with the least effort, is the best. I wish to say a word only about two,—general observation, and the experimental. The relative merits of the two are the same in mental pathology as they are in other fields. We have not yet learned all about the psychology of arrested development that we can by general observation. But what we have learned in this way teaches us at least two things. First, that general observation cannot take us very far without such a degree of refinement as to make it practically the same as the experimental procedure. Secondly, it has taught us enough about the nature of this class of defectives to know that there must necessarily be a large gap between the kind of experimental tests we would wish to make, if we could, and those that we can make, considering the nature of the subjects. One illusion, then, at least, is removed. The experimental enthusiast must learn first of all, that any pre-conceived plan of experimentation that has been the result of his training in a psycho-physics laboratory is doomed to fail. It is of course important to know that a case cannot perform a certain task set him in an experiment, and the determination of the reason why he cannot is still more valuable. But this does not give us the information for which the experiment was devised, and is to that extent a failure. In general, two principles must guide us in determining what kind of a test is to be attempted. First, the nature of the individual case, his grade of general development, and his special characteristics. Second, the particular tasks that he has learned to do somewhat as a matter of every-day life, or school training. To these latter the experiments must be attached as a modification, so adapted as to give us the information we desire.

Before entering into the statement of the results of the tests I have made, I shall give a general description of each case. The sources upon which this description is based are the physician's records, taken from descriptive applications of each case, required by the institution before a case is admitted, and secondly, my own notes taken from general observation during the four months in which the tests were made. The family histories of these cases, as given in the case-book records, were considered with respect to the possible etiological factors that produced the arrest. They presented nothing that is unusual to such histories; nothing that other studies on large numbers do not show much better. The records for these few cases will, therefore, not be given. Their physical measurements were also carefully taken. The results show no striking abnormalities, and are quite in harmony with those of more extensive studies, which show that these defectives are, as a class, a few inches lower in stature, and several pounds lighter in weight

than normals, on the average. In the following section, therefore, there will be considered only matters concerning their general mental development.

II. GENERAL DESCRIPTION OF CASES.

In the following general description of cases the first part for each case, that under "At time of admission," is taken from the physician's records. The second from notes on my own observations. Cases A, B, and C are those of the Mongolian type.

Case A.

At Time of Admission.

At the time of admission into the institution A was seven years three months old. The first observed signs of mental deficiency were the usual ones in most cases of arrested development. His reaction to common stimuli was retarded. 'He did not notice fire, light, or heat, and was always very quiet.' He began to walk at two and a half years. His habits of cleanliness are, at the time of admission, fair. He has learned to wipe his nose and mouth, and does not soil clothes when in health. He can partly dress and feed himself. Puts on stockings, but cannot tie shoe-lace in regular knot. He can use a fork and spoon, wipe and put away dishes, pick up stones and apples, shovel snow or sand, string buttons and beads, swing child in a hammock. He amuses himself with blocks, marbles, building piles, riding girl's bicycle, looking at books. He is fond of music, recognizes color, and probably knows red, green, and yellow by name. He distinguishes cubes from bricks and pictures so as to know them. He usually understands a command and can do an errand. He talks a little, but is limited to the use of eleven words. There is no speech defect.

Present General Observations.

A is now eleven years, having had four years of institutional life. In degree he should probably be classed as about a middle grade imbecile, and he is a fairly good example of the *stupid*, as opposed to the *active* type. In his general movements he is usually slow and clumsy. In his dullest and least energetic moments he shows every sign of chronic laziness. When busy with a task at the table, he soon collapses from a sitting posture, dropping head and hands upon the table, and forgetting his work. In the different tasks the mistakes he makes seem due not so much to an inability to do the work itself as to a lack of inclination. The effort required seems too much, and he works away in the laziest possible manner. On his brighter days or moments he may become more active, and get even a normal degree of life and energy into his movements. When in this mood he may perform his task with interest, and some degree of attention, varying with the kind of work, for he has his likes and dislikes. A lively mood, however, does not always result in interest and attention to the particular task to which he is set. The extra energy may manifest itself in other directions, in his 'own occupations,' such as humming, pounding on the table, rolling and running after the ball, in a test on throwing at a target, etc. In these instances his attention may go to anything but the thing he is told to do, and when thus engaged in something else it becomes exceeding difficult to divert his attention from it.


A
B
C
D
E
F
G
H
I

As a test of general mental ability, and whatever else it might show, two weeks were spent in teaching him the game of dominos, the first week with myself as one of the players, the second with myself as observer and with one of the other cases as the second player Only blocks as high as the double four were used. He had previously learned to discriminate nearly all in a set as high as the double nine, by having one block at a time placed in a circle of ten from which he picked the same block as the one placed in the centre of the circle, two sets of dominos being used in the test. His first difficulty in learning to play the game was in learning to separate the two ends of the block and match by ends only, instead of by blocks, as he had been doing. But after the first few days he had learned all of the purely mechanical procedure of the game. He learned to take three blocks at the beginning of the game, to play by matching an end of his block with one end of the playing line, to wait his turn to play, to draw when he could not play, and to understand that the one who had disposed of his blocks first had beaten. But that he really understood these matters was gleaned from only occasional evidence, evidence that was the exception rather than the rule. About half the time he would not take his three blocks until told. Between fifty and seventy-five per cent. of his plays were wrong. Frequently he would not wait his turn, but keep on playing, his interest being apparently more in stringing out a line of blocks, than to wait his turn, play, and win in the game. He nearly always forgot one end of the playing line, and drew at once when he could not play on the end nearest him. He very frequently overlooked one end of his blocks that would play, and drew unnecessarily. Generally he showed no signs of interest when he or the other player got through first, until he was asked who won. Then he was in most cases interested, especially when he was the winner, in which case he might even laugh and applaud. He very rarely remembered whose turn it was to play first at the beginning of a new game, but generally said "mine" when asked. In general, he showed little interest in the game, none apparently, except in the mere stringing of blocks into a line, possibly some in matching, and most in his recognition of his having won. He plays at random, with little attention to seeing whether he plays rightly or wrongly. He shuffles and pushes about his blocks, knocks them over, and gets them mixed with those of the playing line and of the "bone yard." That it might be to his disadvantage to let the other player see his blocks he never learned, as he did none of the other points of the game.

CASE B.

At Time of Admission.

B was admitted at the age of eleven years two months. His abnormality was first noticed at eighteen months, in backwardness in learning to walk and to talk. He began to walk at four, to talk at about six. At the time of admission he does not know enough to wash or dress himself, cannot tie a shoe-lace, but does not soil his clothing. He can feed himself; uses a spoon, but not a knife or fork. He can do no work of any sort. He does not hide things, but breaks and tears them like any very young child. He is not always obedient, but about like a child of four. He is good tempered, except when crossed. He plays with a sled, and, in the house, plays 'moving,' collecting a pile of things in a corner. His hearing is good, but he is very near-sighted. He is fond of music, does not recognize any of the colors, does not know round from square, but can distinguish photos of friends. He can understand very simple language, and a command,

and will do an errand. He talks a little, but pronounces words indistinctly. Uses only short sentences, never putting more than three words together at a time. He does not count.

Present General Observations.

B is now fourteen years nine months old, with three years seven months of institutional life. Not counting the difference in age, he stands quite noticeably above A in general ability, but would come under the imbecile grade. He is normally active and vigorous in his movements. Among the different tasks given him he showed decided likes and dislikes, working with enthusiasm at times, while at others he persistently refused to work at all. His attention seemed to be good when and where his interest was not lacking. Occasionally he would work for a whole fifteen-minute period with practically no distraction. In these instances he would proceed with every sign of deliberation, and apparently never made a *careless* mistake. In memory tests in which he had to choose a card or picture previously shown from among others before him, he would refuse to choose by mere guessing when he had forgotten, and would in these cases not choose any at all. At the times when he was not interested in his work his distractions were due more to his 'own occupations' than to distractions in his surroundings. Yet, the latter, too, were abundant. These 'own occupations' with him were numerous and various, and very difficult to break up, so as to make him return to his work. Some of them were so constant as to deserve the name of 'tics,' so well known in pathological literature, although most of them did not last throughout the four months of observation. Only the habit of making snorting sounds, and of spasmodic laughing remained permanent. Others would appear only a few times, or for several days or weeks, and then cease. But nearly every day one or two would turn up.

The same attempts were made with B in teaching him the domino game as with A and all the others, excepting C. He had also had the previous domino discrimination test. The ability that he attained in it, and the general character of his playing were so much like that of A that they need little special description. His first difficulty, too, was to learn to match by ends instead of by blocks. He, too, readily learned the mechanical procedure of the game, but always played wrongly oftener than correctly. His interest seemed, too, to be in stringing out a line of blocks, perhaps some in matching, but most in winning. He forgot less often than A to watch both ends of the playing line, and had to be asked less often at the end of the game who won, before he recognized the fact.

B's speech has apparently not developed much since admission into the institution. He still speaks indistinctly and brokenly, and uses only phrases or very short sentences.

CASE C.

At Time of Admission.

C was admitted at the age of ten years. It was noticed from birth that he was backward in every way; was helpless and could not sit up, but began to improve after the second year. He began to walk between four and five years. At the time of admission he does not yet talk. He 'can say some sounds, but cannot connect them. Says papa, mamma, baby, and a great many other words, but not very distinctly.' His habits of cleanliness are good. He does not soil clothing. He can dress and feed himself. He uses a spoon, knife and fork, but cannot tie shoe-lace in a regular knot. He 'can wash and wipe dishes,

and put them away; bring wood and coal, and other wants about the house.' He is obedient and of good temper. He amuses himself as a normal child would. His sight and hearing are good, he likes music, does not recognize colors, knows none by name, and does not recognize form. He distinguishes pictures, understands a command, and can do errands.

Present General Observations.

C has been in the institution for ten months. He is fairly active and lively, more than A, but not as lively as B. His interests seemed about uniform for all the tests. He never showed signs of any particular enthusiasm, nor of any great dislikes for any of his tasks at any time. From outward appearances his attention was not very difficult to get or to hold. He would generally react at once when spoken to, or when otherwise indicated to him what he was to do, provided he understood. And he would go through any of the tests without much relaxation in interest or effort. But upon more detailed observation it became evident that neither his interest nor effort was, as a rule, very great. He performed his tasks in a thoroughly mechanical way, with little change in manner. He did not understand many of the ordinary questions asked him in connection with the tests, but answered all with an ever ready 'yes' and nod, often before the question was completed. Many instances in his procedure showed that a large part of the time he had forgotten just what he was to do, or at least that he did not have his attention on it at all. He did not have any pre-occupations intense enough to hinder his work very much, nor did he seem to be distracted much by his surroundings. In a word, he seemed to have no particular interest in anything, and perhaps never showed any great effort. His speech was limited to some words that were hardly spoken intelligibly. He was never observed to use more than a word at a time. Many things about the tests he could not be made to understand, and the nature of his reactions to questions quite strongly indicated that the main factor in not understanding them was his lack of attention to them. When confused or astonished his eyes revealed a considerable degree of lateral nystagmus.

Case D.

At Time of Admission.

D was eight years eight months when admitted. He began to walk between two and three years, to talk at about six years. He 'has a great laxity of vocal organs, speaks very indistinctly, so that strangers do not understand him.' At six months he had an epileptic attack which increased in severity till three to four years when remedied. Since that time it has greatly improved so that he no longer becomes unconscious, and a word will bring him back to normal condition. His habits of cleanliness are fair. He is learning to dress himself quite well, but cannot tie shoe-lace. He can feed himself with spoon, but does not use knife and fork. He can help clear table, and brings in wood up a flight of stairs. He is generally obedient and good tempered; does not hide or destroy things. He amuses himself with pictures and games with his sister. His sight and hearing are good. He is very fond of music. He distinguishes forms and colors, and knows red and blue by name. He distinguishes pictures, can understand a command, and do an errand.

Present General Observations.

D has been in the institution a year and six months. He should be classed above the imbecile grade. He is quite lively and frequently

gives the impression of one of the active type. But his apparent great activity is rather due to a considerable nervousness. He has his likes and dislikes, the latter of which he frequently expresses. But on the whole he is obedient and will perform his task when told to, even though he dislikes it much. In some of the tests he shows a keen interest. He had a strong sense of rivalry, and could not bear to have his opponent beat him. But, although rivalry aroused him very much, it did not improve his attention to his task, and consequently he did no better on account of it. He manifested more than a normal degree of inquisitiveness, with respect to matters incidental to the tests and what they suggested to him. In some of his questions he was very persistent, and frequently refused to continue his task until he was answered. A number of them were repeated every day with no apparent decrease in interest. He found much more means of amusing himself during unoccupied moments than any of the preceding cases, and he would never sit still, doing nothing, when left to himself. Of this much was stereotyped, for he did the same things over and over again with no apparent change in procedure or interest.

D had no difficulty in learning to play the domino game. He learned to match by one end only, and all the other details in the procedure during the first half hour sitting. He showed considerable interest in winning, and apparently kept that object more or less in mind while playing. He understood that drawing was prejudicial to winning and would be much pleased when his opponent was obliged to do so. He very rarely made a wrong play, but very often drew when he could play on either end, and constantly forgot one end of the playing line, drawing at once when he could not play on the end nearest him, without looking at the other. He could not be made to understand that showing his blocks or telling his opponent what he had might be a disadvantage, and he never learned any of the other points of the game. When his opponent played a double leaving the ends the same as those for which he had just drawn he forgot about the fact and proceded to his own blocks before drawing again.

Case E.

At Time of Admission.

E was admitted when eleven years three months old. He began to walk at fourteen months, and could walk alone at sixteen months. He began to talk at three years, but does not speak normally plain at the time of admission. His habits of cleanliness are good. He can dress and feed himself; can button his front buttons, but not those in the back, nor tie a shoe-lace; uses spoon, knife and fork well. He can feed the chickens, carry wood and coal. He is obedient and very good tempered, and amuses himself like normal children. His sight and hearing are good. He is very fond of music, recognizes color, form somewhat, knows black, white and pink by name, and distinguishes pictures. He understands commands perfectly and can do errands. He knows the alphabet, but makes mistakes. He read a little at school, and can count to about ten.

Present General Observations.

E is now twelve years ten months old, with one year seven months since admission. He stands above the imbecile grade. His movements and general behavior are quite normal. He is active and lively, talks freely and asks many questions, such as any normal child several years younger would ask. He is of the delusional type, frequently met among feeble-minded. He believes himself to be particularly bright, thinks none of the other boys can do things so well as he, that he is a

special favorite, that advanced work is given him because he belongs to a higher class. His one constant interest is closely connected with this attitude towards his abilities. Throughout four months of experimenting a certain set of questions and remarks relative to this estimation of himself were repeated almost daily. Occasionally he expressed dislike of some of the tests, but he was in general obedient, and never refused to go through a test when asked in a kindly way whether he would not do so. Like B, E sometimes gave evidence of what seemed to be very attentive work. He would proceed slowly with apparent care and deliberation, stopping long to consider when in doubt But as will be seen later, these manifestations were no true index of his real powers of attention.

In learning the domino game he showed no appreciable difference in ability and characteristics, in the number and kind of mistakes he made, from that of B. Repeated attempts to make clear to him some of the different points in the game, outside the mere mechanical procedure of drawing and matching, all resulted in complete failure. He was perhaps more pleased than D when he won, but he did not show so much evidence that he kept that purpose in mind while playing, and he also frequently did not recognize that the game was ended when it was.

Case F.

At Time of Admission.

F was four years one month, when admitted. His deficiency was noticed at six months. At the time of admission he does not yet walk, but is just beginning to talk. His habits of cleanliness are poor. He cannot dress or feed himself, cannot use a spoon. His sight and hearing are good.

Present General Observations.

F is now eight years seven months old, with four years six months of institutional life. He is a typical case of the active type, as opposed to the dull, stupid, to which A belongs.[1] He shows more life and energy than any of the other cases. He throws very swiftly with the ball, runs wildly after it, kicking and rolling it about. Placed in a chair during a test, his hands, feet, and body are in a constant wrangling motion, and to sit perfectly still for even a small fraction of a minute is absolutely impossible. In his constant wrangling he soon pulls a table-cloth off the table, mixes up dominos, cards he is using, pushes or knocks off accidentally everything in his reach. His questions are very numerous, occasioned by a variety of things, and show no constant or coherent interest. They are kept up at a uniform rate independently of answers given, for which he seldom waits, and in which he manifests no interest when given. His interests, in general, in the different tests, are uniformly poor. He shows an almost absolute lack of persistent effort in all of the tests. His attention is aroused by everything about him that he sees or hears, and is as readily distracted by the next thing that his surroundings or fancy supplies. This is the one source of constant attraction and distraction that makes it utterly impossible to keep him down to any particular task for more than a few seconds at a time.

To go through the regular procedure of a domino game proved to be beyond F's attainments; not perhaps because he did not understand the game, for occasional evidence showed that he probably understood as well as any of the other cases, but because he was incapable of hold-

[1] See Kraepelin's classification, Klinische Psychiatrie. Leipzig. 1899. p. 573.

ing his attention down to the requirements, and to keep in mind what he was to do and not to do in each case. As a rule, he showed no interest in either the procedure or in winning, yet a few times he applauded loudly when he won, and got angry when his opponent won several times in succession. Over half of his plays were wrong, although he could discriminate the blocks well enough. The idea of adding a block to the playing line from his own was apparently the main thing in his interest, with that of matching as only a secondary matter. Often he would not wait for his turn to play, or play several at a time; would draw at any time merely for the sake of drawing, and constantly overlooked one end of the playing line and draw unnecessarily.

CASE G.

At Time of Admission.

G was admitted at the age of nine years three months. He began to walk at three years, and to talk at four. No abnormality was noticed until the sixth year, when he would get angry easily and bump his head. He showed no tendency to play with other children, and preferred being by himself. At time of admission his habits of cleanliness are fair. He can dress and feed himself; can use spoon but cannot tie shoe-lace. He brings in wood, helps his father feed stone-crusher, hoes, etc. He does not destroy things, but is disobedient, and his temper is not the best. His sight and hearing are good. He recognizes colors, and knows most of them by name. He recognizes pictures, but not form. He can understand a command and do errands.

Present General Observations.

G is now eleven years six months, having been in the institution two years three months. He is fairly active and lively, but rather awkward in his movements. His running and throwing is like that of a child at least several years younger. He is very quiet, never asks a question and seldom speaks; is very obedient and well behaved, at least in the tests. He never protested against any task, and would persistently keep up a test for about an hour without objection or any great lagging in effort. His interest was quite uniformly good, although he had some preferences. From all general appearances his attention seemed better than that of any of the other cases, and he was capable of putting a considerable degree of effort into his work.

He learned at once the procedure in the domino game and never made a mistake in matching. He remembered at the beginning of each game whose turn it was to play first, understood that drawing was prejudicial to winning, was always much pleased to see his opponent draw and himself to win. He could watch his opponent, correct his mistakes, and direct him in his playing. But he drew unnecessarily about as frequently as D and H, by overlooking blocks that would play on either end, and by overlooking one end of the playing line. He could not be made to understand any of the points of the game, beyond the mere mechanical procedure.

CASE H.

At Time of Admission.

H was ten years five months when admitted. He began to walk at about five years, and to talk at about the same time. At the time of admission his speech is normal, with the exception of a 'sort of a lisp.' His habits of cleanliness are good and he can dress and feed himself; can use spoon, knife and fork, but cannot tie a shoe-lace well. He is

obedient and good tempered and does not destroy things. His sight and hearing are good. He recognizes form and color, knows them probably by name, and distinguishes pictures. He understand a command and can do errands.

Present General Observations.

H is now eleven years five months, with one year since admission. He is normally active and lively, talks freely and asks many questions. He is of a happy disposition, laughs much and is hard to anger. He is interested in the 'why and wherefore' of things; wants to know what the apparatus is for, what the different tests are for, why notes are taken, etc. His interests, in general, are fairly good, and quite regular. He seldom objected to a test, and when he did it was rather in the attitude of a joke; he could always be persuaded to perform his task. He was pleased to get things right. His attention could be called to his work with a word He was not very readily distracted and was fairly persistent. Like B, he, as a rule, refused to do guess-work and did not choose a picture or card at all when he had forgotten which one it was, rather than to choose at random.

He was very fond of the domino game, and wanted to play it first every day in preference to any of the other tests. His proficiency in it and the readiness with which he learned was about the same as that of G. He understood that drawing lessened chances for winning, was always pleased to see his opponent draw, and wanted to replace those that he himself drew if they did not play. He readily learned to manage the precedure of the game alone, corrected his opponent's mistakes, seldom made mistakes in matching, but overlooked one end of the playing line and his own blocks in drawing as much as G. His interest seemed to be rather in the procedure with the game than in winning, for he frequently gave no sign of interest in the latter at all.

Case I.

At Time of Admission.

Case I was seven years ten months when admitted. He began walking when a year eight months old, and to talk at about two and a half years. The first observation of defect was that of a convulsion at six months. His habits of cleanliness are fair. He can feed, and undress himself. He uses spoon, knife and fork, but cannot tie a shoe-lace. He can do little errands about the house, is generally good tempered, and usually obedient, but breaks his playthings. His sight and hearing are good. He sometimes recognizes color, knows red and blue by name, and distinguishes form and pictures. He understands a command, and can do errands. He does not speak plainly.

Present General Observations.

I is now ten years five months old, having been in the institution two years seven months. He is very active and lively, but the activity is of the nervous sort, for he is exceedingly nervous. During the first few weeks he was very quiet, and apparently quite attentive. But upon better acquaintance he turned out quite different. His interests are uniformly poor. He is indifferent to all of the tests, even to those that the others liked well. He never protests, excepting a constant complaint that he is tired, and goes through all with about the same degree of effort, which is very small. A word is generally sufficient to call his attention to his task, but he works exceedingly carelessly. All questions that are asked him receive the same affirmative answer, which is given generally before the question is completed.

There is also abundant evidence of another sort that he does not understand the questions at all through lack of attention. His speech is quite defective. His sentences are limited to three to four words, which often begin with an explosive expulsion of the air in the first word.

He had difficulty in learning to match by ends instead of by blocks in the domino game. All the other points in the procedure he learned quite readily. But as in the other tests, he was very careless, and made very many wrong plays, and seldom kept watch of both ends of the playing line. He seemed to regard the game rather as an imposed duty than as a pleasure, although he showed some interest in winning.

With the cases whose speech was good enough to make their answers intelligible, D, E, F, G, H and I, some time was spent with general orientation questions, similar to those outlined by Sioli, and others. The results obtained with this method were so much alike for the different cases that they may be summarized briefly. It is difficult to determine in this way how much they remember of their past life, and whether their memory in this respect is really defective, and to what degree. But one thing seems to be true of all of them as regards memory. There is a very prominent deficiency in keeping fact and imagination apart. Apparently they relate as actual fact whatever comes into their minds. For the same questions asked on different days receive different answers. Their natural train of associations, unhampered by any voluntary inhibition, determines, in general, what they have to say. Numerous special instances reveal this fact quite clearly. Thus, *e. g.*, when asked what they had for breakfast they may relate a large list of things, including anything they had at another time. It is impossible, of course, to determine just how much this mingling of fact and imagination is conscious or unconscious with them. Yet it is clear at once that probably a large part was more or less consciously done. For, on cross-questioning they would correct their previous remarks. Questions on time orientation revealed that they kept very little track of the days, weeks, months, seasons, etc., and that holidays, and events emotionally connected with their lives furnish by far the chief landmarks, if not the only ones, in their knowledge of the progress of time. Further, they showed that they knew many more names and words than they knew the meaning of, for they constantly misapplied them. This, however, differed much for the different cases. When asked to name the seasons of the year, *e. g.*, they may answer, 'Tuesday, Winter, Fourth of July, and April.' Or asked what month it is they may answer with a day of the week, a season, etc. Their idea of number is exceedingly poor, and questions involving it generally received answers very far from correct. Thus, they may say that there are two hours in a day, twelve weeks in a month, four months in a year, etc. None of them could tell time by the clock, nor had any means of indicating that they had even as much as a very vague idea as to how much of the day was past, and how much was left.

III. EXPERIMENTAL RESULTS.

A. Memory.

The tests that were made that would come under this heading were primarily intended for two purposes. First, to determine what the proper method would be for getting evidence that would decide the essential problems that such tests in

general aim at, and, secondly, to get results from the particular cases studied for the sake of comparison with other results.

A large share of the interest in the psychology of arrested development has been directed to the *memory* of this class of defectives. Remarks from casual and general observation on this matter, however, are so general and so various that they afford us but little insight into what the facts may be. The range from profound idiocy to the slightly feeble-minded is so great, the special aptitudes seem to be so common and so marked, and our present knowledge of the class so meagre, as to allow of practically no generalization. Again, the results on the memory span obtained under experimental conditions cannot be compared directly. The methods have been different, and generally too little information is given us as to the age, special training, and the approximate degree of general development of the cases. The following is a résumé of the results of previous experiments on their memory.

Galton tested the memory span of idiots with the reading of figures.[1] He probably uses the term 'idiot' as descriptive of the lowest grade. Their age was 'apparently from sixteen or seventeeen to twenty-five. They could read and write a little, and do some house work, but failed in the adding of two figures.' He tested fifteen cases, reading the figures once distinctly and having the case repeat them orally. He does not state how many individual tests were made on each case. The average of his results from these cases is four, as the number of figures that were perfectly recalled. The three poorest had an average of two figures, and of the six best five had an average of five figures, and one of six. The results of another visit to another institution, where most of the inmates were of the imbecile grade, were as follows: 28 cases tested, classed into four groups according to the estimated degree of general intelligence. In the lower classes letters instead of numerals were read, in all the child beginning to repeat immediately after reading. Class I, ages nine to fifteen, gave an average of 7. Class II, ages nine to sixteen, averaged 4.5. Class III, ages eleven to nineteen, averaged 3.09. Class IV, ages eleven to fifteen, averaged 3.33.

Johnson experimented with seventy-two cases, using the reading of numerals as a method, the child repeating orally immediately as many as it could.[2] He used series of three, four, etc., to eight numerals. Six repetitions of each series constituted a test. Of the seventy-two cases thus tested,

70 repeated 3 numerals correctly.
66 " 4 " "

[1] Mind, 1887.
[2] Psycho-Asthenics, Vol. II, No. 2.

51	repeated	5	numerals	correctly.
27	"	6	"	"
14	"	7	"	"
4	"	8	"	"

Arranging the cases according to the degree of their general development, he concludes that 'there was generally an increase of memory with intelligence, but there were notable exceptions.'

Wylie has tested fifty-one cases on visual and auditory memory, and thirty-four on the memory of muscular movements.[1] The age of the fifty-one cases ranged from fifteen to thirty years. Twenty-five of them were boys. Of the thirty-four, seventeen were boys. He gives no further description. For the visual tests he used three series of stimuli. (1). Ten cardboard forms. (2.) Ten colored papers. (3.) Ten consonant letters on cards. Five of each series were presented to the child for two seconds, and immediately it picked out as many of them as it could from a duplicated series of ten placed before it. Each series was repeated five times. He found the average number of correct choices to be as follows:

	Form.	Color.	Letters.
Girls 26	2.3	2.4	2.5
Boys 25	2.5	2.3	2.7

For the auditory test he used, (1.) groups of five nonsense syllables, as free from association as possible. (2.) Groups of six associated words. (3.) Words making sentences, from their school readers from five to thirty-five words in length. The syllables and words were read at the rate of one per second, the child repeating them immediately. The average number of syllables and words correctly repeated were:

	Syllables.	Words.	Words in Sentences.
Boys	2.1	3.9	10
Girls	2.1	3.7	12

In the test on the memory of muscular movements a graduated rod with two stops was fixed on supports before the child. With closed eyes the child moved the index finger from first to second stop and back. The second stop was then removed, and the child required to move finger again to the position where the second stop had been. Three distances between stops were used, 100, 200, and 300 mm., respectively. Three intervals, 0-seconds, 10-seconds, and 20-seconds, between first movement and reproduction of movement were used. He does

[1] See Psycho-Asthenics, Vols. I-IV, for a number of different experiments made by him.

not state the number of trials for each case. His results are:

	0-sec.	10-sec.	20-sec.
Boys 17	108	111	144
Girls 17	108	113	108
Boys	311	279	271
Girls	287	282	277
Boys	490	463	447
Girls	476	457	456

Grouping these cases into three classes according to degree of general development shows their memory span, and accuracy of memory of muscular movements parallel with the degree of intelligence, in a general way.

Recently, Lobsien, also, has made a memory span test on mental defectives.[1] He used nine stimuli, given to a group of children at ten seconds intervals, for each of eight different classes of stimuli, as follows: (a.) Nine objects seen. (b.) Nine noises made. (c.) Nine numbers called. (d.) Nine words called suggesting visual imagery. (e.) Nine words called suggesting auditory imagery. (f.) Nine words suggesting tactual imagery. (g.) Nine words suggesting emotions. (h.) Nine words whose meaning was not known to the children. The experiment was a repetition of one he had previously made on normal children.[2] In each case the children wrote down immediately as much as they could remember. He compares the results of normals and defectives. The following is taken from his tables. The figures express percentages correctly recalled.

	a	b	c	d	e	f	g	h
Defectives (age 10–12),	71	43	26	39	24	35	31	8
Normals (age 10–12),	87	54	64	61	59	61	51	11
Difference,	16	11	38	22	35	26	20	3

His results, when grouped according to grade of general development, also show that memory span decreases with this grade.

A number of other experiments have been made by different persons on the memory span of normal children and of adults. Comparison of these results with those from children arrested in development shows the latter to be considerably deficient in memory span, at least in the averages, and granting that no other factors have entered with the one class. Thus Johnson, on comparing his results with those of Jacobs, Bolton, and Bourdon, concludes that 'the feeble-minded fall considerably

[1] Lobsien: Einige Untersuchungen über das Gadächtniss bei Schwachbefahigten. Die Kinderfehler; Zeitschr. f. Kinderforschung. Bd. VIII, H. 4.

[2] Lobsien: Experimentelle Untersuchungen über die Gedächtniss-Entwickelung bei Schulkinder. Zeitschr. f. Psych. u. Phys. d. Sin. Bd. XXVII, 1902.

below normal children in memory span. But the memory span is so good in some cases, and the average for the majority is so high, that we are led to conclude that the degree in which the memory span of feeble-minded falls below that of normal children is not commensurate with the degree in which the feeble-minded fall below normal children in general intelligence.' He believes that their deficiency in memory span is largely due to deficiency in attention and will power, and that 'hence we may conclude that weakness of memory, physiologically speaking, is not a special prominent factor in feeble-mindedness.' Wylie's results on the memory of muscular movements, compared with those of Scripture from adult normals show 'the memory error of feeble-minded to be from two to ten times that of normals.' Lobsien concludes from his results that roughly the memory of normals is to the memory of imbeciles as five to three.[1]

Great differences and irregularities are undoubtedly a constant feature with this class of defectives. The fact to which Johnson attributes a general lowering of memory span is responsible also for a great variation, since great irregularity is one of the expressions of poor attention. The extent and nature of this factor is one of the chief things that we need to know more about, for it is evident from only a superficial observation that poor and irregular attention is one of the main lines of deficiency. But in order to do this, and also to determine more closely to what extent they are really defective in memory, it is necessary, I think, to observe a more rigid control of the tests and refinements of method. It is to a few conditions that should be considered, which one learns best after having had some experience with the cases, that I wish to call attention. I have already noted that in comparison of results of different cases with each other and with those of normals in any particular test it is quite necessary that the ages and general development of the cases should be nearly alike. The judgment of general ability can be made with much greater ease and accuracy in observing the cases themselves than such differences can be described, and the demand really involves no great difficulty. But of equal importance with this is the consideration of the amount of institutional training each case has had, and his degree of familiarity with the special stimulus used

[1] See his article in Kinderfehler, p. 202. For results of other experiments on the memory span of normal children, with methods very similar to that of Lobsien, see Netschajeff: Experimentelle Untersuchungen uber das Gedächtniss-Entwickelung bei Schulkinder. Zeitschr. f. Psych. u. Phys. d. Sin. Bd. XXIV, 1900. Also, Ueber Memorieren. Eine Skizzie aus dem Gebiete der experimentellen Pädagogischen Psychologie, by the same author, in Sammlung von Abhandlungen an dem Gebiete der experimentellen pädagogischen Psychologie. Bd. V, 1902.

in the test. Home life and institutional life are too frequently two quite different matters with sickly and defective children. Entrance into the institution often results in a great improvement in general health, when all their special needs are looked after by competent hands. Long and persistent special training adapted to the nature of their deficiencies brings about a second great difference between those outside and those in the institution. When these facts are considered in connection with the effect they may have had upon the familiarity of each case with the special stimulus used in the test, their importance becomes at once evident. Discrimination, and recognition of forms, letters, words, and numerals is with many cases the result of a long process of learning, quite different from that of any normal child, and quite different from each other. What the defective case does in a test depends in the first place upon how well he can handle the stimulus. The figures from Lobsien's tables, given above, strongly suggest this fact. From them it is seen that the difference in memory span for the two classes of children is much less when the stimuli are actual objects seen, and actual noises heard—a, and b—than is the case when the stimuli are only words called suggesting the different imagery—c, d, e, f, and g, h being an exception. The first explanation for this that suggests itself is that the normal children have developed a better word memory through several years of school training which the defectives have not had. In any case, it has long been known that memory is memory for particular things, and that it may be widely different for different things, according to the experience and interests of the individual. Again, if we wish to determine how far the memory span result is due to deficient memory, and how far it is due to poor attention, the first prerequisite is the observance of special means of insuring uniform perception of the stimulus. If several things are merely placed before the child and he is left to himself to see them, it will mean that in some trials he will not notice any at all, while in others his attention may be quite normal. The averages may then be a measure of irregular attention rather than poor memory. The same factor will be present when the child is required to recall or recognize what stimuli have been given. Unfortunately there seems to be no means of eliminating the effect of poor and irregular attention at the latter point. Lastly, if any interval is used between the presentation and recall of the stimulus, it is absolutely necessary that some efficient means of distraction should be employed during the interval. For reducing the effort to keep the stimulus in mind to zero is the only method of keeping that effort uniform for the different cases and for each case in successive trials. Unless this is done the stimulus may, furthermore, be remembered by some symbol, name or other image associated

with it, rather than directly, and the liability and accuracy of memory will then depend not upon the stimulus itself, but upon its associations.

With the observance of these general conditions the details of the procedure in the particular memory test must be dependent upon the particular problem that we wish to study. In the memory span work the problem, as usually stated, is to determine the limit of the ability in recollecting a number of stimuli immediately after a single presentation. The first choice between methods at this point lies between that of the recall and the recognition methods. In the one case the subject reproduces the stimulus, either itself or by symbols. In the other the stimulus is repeated for him together with some others, and the subject has only to discriminate between those presented, and those not presented before. The first, recall method, is the more active process, requiring attention to one's imagery, while, in the second, the recognitive processes are more passive, following immediately the re-presentation of the stimulus. If the feeble-minded are especially defective in attention it is evident that figures in the results of the two methods are not to be compared directly with reference to memory ability.[1] In the majority of cases of these children, however, choice is determined by the nature of the case, and the kind of stimulus that can be employed at all. If speech is very defective, as it often is, a large number of possibilities in method are eliminated. With such cases one is practically limited to the recognition method, unless they can write well and one resorts to the procedure of having them write down the names of the stimuli in recall. If the child has not yet learned the names of the stimuli to be used, *e. g.*, numerals, letters, diagrams, colors, etc., the recall method is also out of the question, for he will have no means of expressing, as in case of defective speech, what he remembers. Thus, in general, the recognition method is applicable with low grade cases where the recall method is not. But it has two decided disadvantages. For, in the first place, the number of things from which the child is to choose those that have been presented before must be kept small; if it is large he will weary of considering them all, and will choose at random. On the other hand, the smaller it is, the larger will be the element of correct guesses.

The memory span work, however, does not decide a number of things that are of fundamental interest in the study of questions that would come under memory studies. Here at once it

[1] The difference between these two methods was frequently verified in my own tests in which a series of ten pictures was used, employing the recognition method. When the child was asked to name the pictures, during the interval, that had been shown him he could usually recall only one or two. But when it came to picking them out from the ten he had no difficulty.

falls into two main lines of problems, viz., 'What is their so-called physiological retentiveness, the inherent persistency of the primary image? And secondly, what is the nature of their memory of a group of associated processes? When we are concerned with the former all possibility of associations with the stimuli must be ruled out. In either case we may concern ourselves with their memory span, or with their memory as dependent upon duration since the stimulus. It is not at all a priori certain that two children with the same memory span will also have the same memory curve as based upon duration. Of associations with the stimuli that are apt to occur the most important is the association between the stimulus and its name. Hence, except in the case in which the effect of their presence is the object of study, an arbitrary stimulus should be used for which no possible name can be invented, and which is also not apt to be remembered by any other symbol. Unless this is avoided our purpose is defeated, for the child may remember the stimulus during the interval by repeating its name to himself, or by some other symbolic representation that would be easier to keep in mind than the stimlus itself, as already noted.

My experiments on the memory of the nine cases described above can make no pretention at having been performed under the favorable conditions and methods outlined. The main result of the memory tests has rather been to raise questions and to suggest refinements of method. Two sets of memory tests were made. One in which the child was asked to name as many as he could of a group of ten pictures[1] that were being used at the same time in the second set of memory tests, a memory span test by the recognition method. After three weeks of memory span work with these ten pictures each child was asked to name as many of the pictures as he could each day before seeing any of them. This was continued for seven days. Then after an interval of five weeks during which they saw none of the pictures in any test, the same was repeated for two days without the pictures being shown. Each time persistent coaxing was employed so as to eliminate as far as possible the effect of mere unwillingness to try to recall them. The following table gives the results in percentages. Only the results of the last two days before the five weeks interval is used in the first column.

In the memory span test the same ten pictures were always used. Each day two, three, four, and five pictures at a time were shown each case, which, after an interval, he tried to pick out from the ten. The whole was repeated sixteen times

[1] Pictures of a goose, chick, pig, cat, horse, shoe, bag, necktie, umbrella, and scissors were used, taken from Reed's card-board object pictures, as advertised in Milton Bradley Co.'s catalogue on Kindergarten Material and School Aids. Springfield, Mass., 1903.

TABLE I.

CASES	A	B	C[1]	D	E	F	G	H	I
Before 5 week's interval	85	75		80	80	70	95	85	80
After " " "	75	75		70	65	65	65	45	75
Loss	10			10	15	5	30	40	5

for each case. In showing the pictures the child was made to name those shown twice over as I pointed to them, so as to secure uniformity of perception. Four intervals were used between presenting the pictures and picking them out from the ten, viz., ten, twenty, forty, and eighty seconds. But the fact that nearly all of the cases remembered at times during the interval by repeating the names of the pictures to themselves quite defeated the purpose of determining the relation between their memory span and the interval between stimulus and recollection. The percentages of correct choices made when two, three, four, and five pictures were shown are given in the following table. The figures given, however, are those after correction has been made for the number that could have been chosen correctly by mere guessing, due to the fact that the pictures were always chosen from the limited number of ten. Thus for the per cent. of correct choices made when five pictures were shown 50% is deducted, for four pictures shown 40% is deducted, etc., from the number of correct choices.[2]

TABLE II.

CASES	A	B	C	D	E	F	G	H	I	AV.
Two pictures shown	80	80	64	80	80	80	80	80	80	78
Three " "	43	57	[illegible]	68	66	60	70	70	65	58
Four " "	29	41	27	49	52	38	51	41	10	38
Five " "	20	36	19	44	[illegible]	35	31	32	30	32
Average	43	54	34	60	61	53	58	56	46	

It will be noted from the figures that the memory span for these cases, with pictures, lies between two and three. C alone made any mistakes when as few as two were shown, while G and H alone made no mistakes when as many as three were shown. The averages in the lower column have no significance except as a means of comparison of the cases with one another. A comparison with the preceding table will show no direct relation between memory permanency and memory span. The two tables show the order of proficiency in memory permanency during a long interval, and memory span to be the following:

[1] C's speech was entirely unintelligible, and hence no results could be obtained from him in this test.

[2] It will be remembered, however, that this introduces another error at or near the limit of absolute certainty in the memory span. Thus, most of the cases made no mistakes at all when only two pictures were shown, but after deducting for chance error they have only 80% of correct choices.

B — (I—F)—(A—D)—E—G—H, and
E—D—G—H—B—F—I—A, respectively.

Peculiarly, this gives an inverse relation; the four best in memory span are the four poorest in memory permanency. If, from the first table, we compare the order of proficiency in remembering a large number of pictures in the first place with the order according to memory permanency we have:

G—(H—A)—(D—E—I)—B—F, and
B—(I—F)—(A—D)—E—G—H, respectively.

Here G, H, and A, the best in remembering a large percentage of the pictures before the five weeks' interval, are among the poorest in memory permanency. This would correlate high memory span and high proficiency to commit to memory, with a low degree of memory permanency. When we remember from the psychology of memory in normal persons that that portion which is committed to memory under a high pressure of effort and attention is least permanent, then these relations become more intelligible. We may have here an analogous instance. The poorest cases show the greatest memory permanency because they have in the first place remembered only so much as could be done without effort.

Comparing the results for the different intervals, ten, twenty, forty, and eighty seconds, between showing the pictures and their picking them out from among the ten, shows practically no effect of the interval upon the memory span. The averages are exactly the same for all the intervals, excepting the eighty seconds, for which it drops 3%. This was undoubtedly due to the factor already noted, viz., that some of the cases remembered the pictures during the interval by repeating their names to themselves.

Incidentally the test has brought out the fact that there were some instances of decided memory preferences, in the case of the ten pictures used. They would remember some pictures better than others, and forget some more frequently than others. In Table III the percentage of the number of times each picture was not chosen when it had been shown, and the percentage of the number of times it was chosen wrongly, when it had not been shown, are given.[1] In the first horizontal column for each case are given the percentages forgotten, in the second, the percentages chosen wrongly for each picture.

A study of these figures will show that in the large majority of instances those pictures that have been forgotten most are among those that have been chosen wrongly least. The most probable interpretation of these facts is that a certain picture is chosen wrongly more frequently than another because it pos-

[1] The picture of the bag was not shown at all. A chose it wrongly twice, E once and I twice; the others never.

TABLE III.

	Goose	Chick	Pig	Cat	Horse	Shoe	Necktie.	Umbrella	Scissors	M V.
A	18	28	13		22	25	47	13	[illegible]	10
	3	3	2	6	3	1	4	5	3	1
B	13	19	6		[illegible]	19	19	6	25	7
	3	3	[illegible]	1	1	2		2	1	.77
C	13	38	6	19	22	50	47	18	50	14
	8	3	4	6	3	2	3	4	1	2
D	25			6	3	6	[illegible]	6	19	7
		2		1			2		1	.66
E	13	13	6		6	3			[illegible]	4
							1	2	[illegible]	.57
F	25	16	6		3	31		18	13	9
	1	2		2	1		2	4	3	1
G	6	13	6		6	13	19		13	5
	[illegible]			1			2	2	. 1	.79
H		6	19		16	28	3		19	9
	1	[illegible]		4			1	2	1	.89
I	50	22	41		19	34	28	13	25	11
	3	3		6	5		2	[illegible]	4	1.6

sesses the greater interest. When the child has quite forgotten which the right one is, it is pretty certain that he will choose either the one that is nearest or that his eye happens to rest on, or he will pick according to his likes. Why he should forget one picture oftener than another is more evident. Interest determines the persistency of his imagery. If he likes a certain picture better than the others, or has more associations connected with it, its image will be easier to hold, while at the same time he is incapable of the effort of attention to keep the others in mind. Consequently, he forgets some always, and remembers others. The figures for the picture of the cat show very clearly what the effect of interest has been. Although one would expect that the interests of the different cases would be in different pictures, and this Table III shows, yet the averages show that the pictures themselves have a considerable independent memory value. The following table gives the averages for the nine cases, from the percentages in Table III.

TABLE IV.

Goose.	Chick.	Pig.	Cat.	Horse.	Shoe.	Necktie.	Umbrella.	Scissors.
18.1	17.2	11.3	2.5	11.3	23.2	18.4	8.2	23.6
2.3	2	.7	3	1.4	.6	1.9	2.6	1.8

Here it will be seen that the pictures of the shoe and scissors lead in being oftenest forgotten, while the former leads also in being chosen wrongly least of all, and the latter stands fourth in this respect. Pictures of the cat and umbrella were by far the best remembered, and they are also the two that are chosen wrongly most frequently.

The fact that these results show memory preferences is in itself of no significance. It is only the degree of it, under the particular conditions of the experiment, that is of value. It has long been known that memory with normal persons differs for different things.[1] Unfortunately, on account of the different conditions of my test, my results cannot be compared directly with any others. But that memory preference is a characteristic especially of mental deficiency is seen at once upon comparison of the results in Table III for the different grades of cases. The poorest cases, A, B, C, and I, present the most striking instances of memory preference. The last column of figures on the right, mean variations of the figures in the table, give a measure of the degree of memory preferences for each case. The average of these mean variations for A, B, C, and I is 10.5, and 1.34 for percentage forgotten and percentage chosen wrongly, respectively. For the better cases, D, E, F, G, and H, these averages are only 6.8 and .78, respectively.

B. Practice.

1. *Throwing at a Target.*

In a general way we know, of course, that the feeble-minded are deficient in the ability to gain in practice in any kind of work. The designation 'arrested development' is only another way of expressing the fact that there has been an inability to learn. And to gain in practice is nothing more or less than learning. We know, too, that the details of the nature of the practice curve with perfectly normal persons are subject to very great variations; that these variations are dependent upon the nature of the work, and upon the individual, besides many other minor factors.[2] These things considered, it was the purpose of the following practice tests to furnish some standardized means of studying the factors that enter into the practice curve of this class of defectives, and to compare them with those that we know to be present in determining the practice curve of normals. Granted that the two are different, and that practice gain, especially, is slower with the former than with normal children, a practice test under simple and controlled conditions

[1] From an experiment von Tschisch concludes that memory is different for the different sense departments. See Dritter internationaler Congress für Psychologie in München, 1896, p.95. The figures computed from Lobsien's tables, given above, show how memory differs for different *classes* of stimuli for both normals and defectives. His tables and curves on results from normals alone show this even much better. For an excellent discussion of this and related points, see Stratton: Experimental Psychology and its Bearing upon Culture. New York, 1903.

[2] See especially articles in Kraepelin's Psychologische Arbeiten. Vols. I-IV.

ought to reveal an essential difference in the factors that enter in the two instances. In the present work two motor tests were chosen as best fulfilling the requirements for such a test. One consisted in throwing with an uncovered tennis ball at a large target, the other in tapping on a re-action key in unison with the beats of a metronome. In the throwing test a target forty inches in diameter was used. It consisted of alternating black and gray rings, four inches wide, with an orange colored central spot five inches in diameter bordered by a black ring one and a half inch in width. This orange and black centre gave a good contrast and thus helped to fixate the attention upon the centre of the target, and to avoid throwing at the target in general instead of at the centre. The whole target was marked off into octants. In recording the results both the octant and the ring hit were recorded. The black and orange centre counted five, the next ring four, etc., to the outside ring counting one, and outside of all rings, zero. The target was hung so that the centre was about a foot below the level of their shoulders. To make hitting the centre about equally difficult for all, they were divided into two groups, A, C, and G throwing at a distance of twelve feet, and the others at fifteen feet. Each case threw twenty times a day, for four consecutive days of the week, and continued for seven weeks. Two cases were taken at a time. Every means of exciting their interest and rivalry in hitting the centre was constantly employed. To avoid their becoming weary of their task each day, the two that were taken at a time alternated by five throws at a time. But this seemed to be unnecessary precaution, and, after the second week, they alternated with ten throws at a time. On account of the odd number of cases C generally,—a few times A, and B—threw alone, and after the second week threw the twenty times each day without pause.

In this test there are a number of ways in which practice effect might have been expected. In the first place, the number of points gained per day should increase. Secondly, where there is a constant error, *i. e.*, constant hitting in the same quadrant of the target, this should decrease. Thirdly, the regularity of the throw for each day should increase. Fourth, if there is each day an effect of weariness, so that the last throws on each day are poorer than the first, or if there is an arousal to the task, so that the last throws are the better, practice should effect these factors. Fifth, the daily variations should decrease, *i. e.*, practice should make the results more independent of the changes in daily disposition. The results are insufficient to give any definite evidence on all these matters, and probably because the last three factors—weariness, arousal, and daily disposition are too variable and complex to make a clear

interpretation of the results possible. I shall give the results on these matters in the order indicated.

The practice curves based upon the weekly averages of the number of points gained per day are very irregular, as is seen in Table V. Yet, after the first three weeks it was clear that the curve would not be like that usually obtained with normal subjects. It does not rise rapidly in the beginning, but hardly at all, and soon begins to drop actually below the point at which it started.

TABLE V.[1]

Weeks.	1	2	3	4	[illegible]	6	7	Av.
A	37	40.5	38	36.25	36.5	33.75	34.25	36.61
B	41.25	28.5	38.75	36	43.5	36.75	[illegible]	37.68
C	38	49	38	36	41.5	——[2]	43	36.61
D	33.25	24.75	30	26.5	29.25	31.75	34.75	39.97
E	44.75	44.5	28.5	39	42.75	43.25	41.75	40.79
F	31	33.75	27.75	22.75	32.25	34.5	31.5	30.5
G	49.25	56.25	55.75	50.25	57.25	59.25	60.5	55.5
H	45	41.75	43	44.5	44.5	40	46.25	43.59
I	32.75	37.5	25.25	24.75	31	21.75	18.75	27.36
Av.	38.36	39.67	36.06	35.11	39.83	37.63	38.86	

The cause for this decline in the curve is not far to seek. Only one interpretation is possible, and many other general observations also bear it out. The novelty of their task soon wears off, they become gradually more tired of it, and hence throw with less interest and attention. The conditions affecting their interest did not remain the same throughout the seven weeks. It is a generally recognized fact that feeble-minded children do better in their general class work when a stranger is present to watch them. This was the case in the present test during the fifth and sixth weeks.[3] On the last day of the fifth week a maximum systematic coaxing was tried, attempting especially to arouse their rivalry, in order to see what effect this would have on the curve. During the sixth week no extra coaxing was employed. The grouping of the results with respect to these factors that affected their general interest and attention is instructive.

TABLE VI.

	A	B	C	D	E	F	G	H	I	AV.
Av. 1st and 2nd Wks.	38.75	34.88	43.33	29	44.63	32.38	52.75	43.38	35.13	39.36
Av. 3rd and 4th "	37.13	36.75	37	28.25	33.75	25.25	53	43.75	25	35.54
1st 3 days of 5th "	34	43.5	43	26.33	39.33	32.66	60	43	24.66	38.81
Last day " " "	44	44	37	29	53	31	49	49	50	42.89
Av. of 6th "	33.75	36.75	——	31.75	43.25	34.50	59.25	40	21.75	37.63
Av. of 7th "	34.25	39	43	34.75	41.75	31.5	60.5	46.25	18.75	38.86

[1] It will be remembered that A, C, and G threw at a distance of twelve feet, and the others at a distance of fifteen.

[2] Omitted on account of sickness.

[3] Dr. J. W. Slaughter, Docent in Clark University, kindly helped me with the tests and in taking down observations during two weeks.

The main things to be noted in the figures of these two tables are perhaps, first, great irregularity in the curve for each case. In table V the figures are weekly averages, based upon the number of points made in twenty throws a day for four days. Yet the weekly variation reaches 50% in one instance. Many of the daily variations are much higher. Secondly, the matter of interest and effort really to hit the centre has been the main factor in determining the course of the curve. It is only in the general average for the nine cases that any genuine practice effect is noticeable, and here it is slight. The average for the second week stands only a little above that of the first, and after that it clearly drops until the fifth week. Decrease in interest and attention make the curve go down. Thirdly, the extent of the influence of these is seen in the general averages in Table VI. Where a special attempt was made to raise them to a maximum, in the last day of the fifth week, the average is 42.89, considerably above any other average. During the sixth week the average falls again below that of the fifth. What the high average in the seventh week is due to is not entirely clear. In D it was quite noticeable that the sense of rivalry that had been quite well aroused during the preceding weeks continued in the seventh. On the other hand, H, who kept up a high average in the seventh week, did not seem to show any such permanent change in attitude towards his task. However, considering the results on the whole, it is more probable that the high averages of the sixth and seventh weeks are due to the more or less permanent change in attitude caused by the previously aroused rivalry, a change that might readily escape notice in general observation, than that they are directly due to a real practice gain.

Although the actual number of points made per day decreases, thus showing that the effect of practice is less than that of other factors, practice effect is seen in other ways. In throwing at the target most of the cases showed a considerable constant error; they constantly hit in one half of the target more than in the other. This fact has other interests besides that of the influence of practice upon it. But we must note in the first place that with practice the amount of this constant error decreases with most of the cases. Table VII gives the constant errors in percentages for the first three weeks and the last three, for each case.

Thus, for the first three weeks 60% of A's hits were in the upper half of the target, during the last three weeks 64% were in the upper half. The figures in the first two columns show in the first place one way in which decrease in interest resulted in decrease in the number of points made per day. Here it is seen that six of the nine cases, B, C, D, G, H, and I, threw low

TABLE VII.

		Upper half.	Lower half.	Change.	Right half.	Left half.	Change.
A	1st 3 Wks.	10			9		
	Last " "	14		+4	7		—2
B	1st " "	7			13		
	Last " "		1	—8	3		—10
C	1st " "		13			7	
	Last " "		17	+4		23	+16
D	1st " "		3			9	
	Last " "		17	+14		6	—3
E	1st " "		17		2		
	Last " "		3	—14	0		—2
F	1st " "	5			8		
	Last " "	12		+7	2		—6
G	1st " "	4				4	
	Last " "		5	—9		0	—4
H	1st " "	13			3		
	Last " "		3	—16	12		+9
I	1st " "		16		24		
	Last " "		29	+13	11		—13

more frequently during the last three weeks than during the first three. With lack in interest has been correlated a lack of effort to throw hard enough. The other three have increased the speed of their throw, two of them, A, and F, increasing their constant error, and the other, E, decreasing it. On this account these figures comparing the number of hits in the upper half with the number in the lower half lose their significance as regards the effect of practice upon the constant error. But the others show that seven of the nine cases have decreased their constant error in the right or left half of the target, while C and H have increased it. The reason why there should be such a constant error in the first place is undoubtedly that a characteristic swing of the arm and manner of grasping and releasing the ball in throwing has already become fixed, and this is, to the extent of the error, out of adjustment with the perception of the spot that is aimed at. At the same time it is safe to say that the correction of the error has not been a conscious correction. It is not to be supposed that any of these children noticed that they threw 10 to 15%. for instance, more frequently in one half of the target than in the other, and consequently made allowance for such an error. The adjustment, then, has been an unconscious one, and involved the breaking up of a more or less established motor habit.

A second way in which the results show a real practice effect

is in an increase in the regularity of the throw. The hits tend to accumulate on the intermediate rings of the target, thus approaching a sort of an average throw. In table VIII the results of the first three weeks and of the last three are again compared with reference to this point.

TABLE VIII.

	A		B		C		D		E		F		G		H		I		AV.	AV.
0	62	70	72	66	63	51	99	87	60	56	93	94	22	13	48	52	83	120	66.89	67.67
1	39	41	39	30	47	31	32	40	39	32	37	23	32	23	42	36	45	35	39.11	32.33
2	36	54	47	47	31	45	47	42	45	47	37	43	48	35	42	51	39	35	41.33	44.33
3	37	41	34	49	50	49	32	36	36	52	39	45	65	81	55	40	37	24	42.77	45.22
4	32	24	31	34	25	30	20	24	31	36	22	26	43	68	32	40	27	15	29.22	33
5	15	10	17	14	23	14	10	11	19	17	12	9	30	20	20	21	8	11	17.11	13.11

The first vertical column for each case gives the number of hits for the different rings of the target during the first three weeks, the second vertical column gives the number during the last three weeks. The figures 0 to 5 in the first column designate the rings of the target, 0 standing for outside all rings, and 5 for the centre. In considering the averages in this table it will be noted that the 0-column for the last three weeks is high on account of the very exceptional record of I. From the preceding table it will be remembered that I increased the number of hits in the lower half of the target 13% during the last three weeks. The records of his individual throws also show that during this time he threw below the target, outside all rings, much more than at first. Consequently the average of 67.67 in Table VIII is too high, it being raised not by an increase in irregularity of I's throw, but by his becoming weary of the work and too lazy to throw hard enough. This exception aside, it is seen that during the last three weeks the hits accumulate on rings 2, 3, and 4 at the expense of the others. In Table V the average of the average for all cases for the first three weeks is .74 lower than the same average for the last three weeks. Thus the first and last three weeks is practically the same. The increase in regularity of the throw is, then, independent of any factor that increased or decreased the number of points made. This is true not only of the general averages, but also of the exceptional cases whose throw became gradually poorer, although more regular. This is seen best in the results of A, and E, in Tables V and VIII. Taking these facts together, it is clear that in this increase in regularity we have to do with a genuine practice effect. As to just what in the total process the practice is to be attributed, there may be some question.

So far only two factors, viz., interest and attention, and practice, have been noted that entered in determining the number of points made in throwing. There remains a third, daily disposition, a very important one, as will be seen. In Table IX

are given the daily mean variations in the number of points made per day, for each week. Here the 6.67, *e. g.*, for A is A's daily mean variation during his first week. It is seen that the general averages for all cases in the lowest column change from week to week. They show an interesting relation when

TABLE IX.

Weeks.	1	2	3	4	5[1]	6	7
A	6.67	9.25	.5	5.13	1	2.75	8.25
B	5.75	9	7	2.5	7.57	3.75	2
C	4.22	2	7	2	4.67	——	2.5
D	5.63	8.63	11	3.25	1.78	4.75	5 75
E	2.38	6	4.75	3.5	6.44	2.75	5.25
F	6	4.25	3.38	4.25	3.11	9.25	4.25
G	4.75	4.75	5.25	4.25	6	4.38	3.5
H	2.5	5.75	3	3.5	8	3.5	7.88
I	4.25	3.5	6.25	4.13	5.55	3.75	3.88
Av.	4.88	5.90	4.24	3.60	4.90	4.36	4.81

compared with the general averages in Table V, giving the average number of points made from week to week. This shows that the daily mean variation runs parallel, week for week, with the number of points made each week. It is greatest on the weeks in which the number of points made is greatest, and smallest where the latter is smallest. Now, since the daily variations are due to changes in the daily disposition, incidental factors aside, this means that the high averages in points made are due to great spurts on days when they felt inclined to do so, when their general disposition was good. This fact taken in connection with the results previously stated makes it possible to account for the changes in the daily mean variations from week to week, and also the interpolations of all the main factors that entered in determining the curve. It was seen before that the averages in the number of points made fell during the third and fourth week, and rose again in the fifth; and that this was due first to a decline in their interest in the task, and second, to an increase in that interest when, during the fifth week, it was artificially aroused. It is seen now that high records were due to a favorable daily disposition. The effect of these two factors, high interest and favorable disposition, upon the curve should, a priori, be the same. Each should raise the average. Their character, psychologically, is alike, in so far that high interest in a particular task means favorable disposition towards that task, and *vice versa*. But interest is dependent upon the particular task, may be limited to it, is, in

[1] The mean variations for the fifth week are based on the first three days of the week only, since on the fourth day of that week the throwing was better on account of the special and systematic coaxing introduced then.

the present case, highest in the beginning and soon wears off. Daily disposition, on the other hand, is independent of the particular kind of work, varies independently of it, and is probably connected with changes in health, general metabolism, and the like. Now what the figures in Tables IX and V suggest is that favorable disposition did not necessarily imply high interest in the particular task, but that the former was necessary for the latter. For, during the first two weeks high variations and high averages in the number of points made go together. When that interest drops during the third and fourth week, lowering the averages, the mean variation drops also, showing that the changes in daily disposition did not alone effect the curve materially in the absence of the other factor. With the artificially aroused interest in the fifth week the averages rise, but the mean variations rise also, showing that the possibility of arousing their interest was dependent in the first place upon their favorable disposition.

Two other facts, one obtained from general observation, and the other seen in Table V, enforce this interpretation. It was frequently illustrated that a particularly lively mood on a certain day did not necessarily mean an increased interest in hitting the centre of the target. The unusual energy was spent, naturally enough, in other ways, in bouncing and chasing the ball about the room, *e. g.*, rather than in an activity which they had come to dislike more or less. Secondly, it will be remembered that case A was described as one of 'chronic weariness.' In other words, he had a permanent unfavorable disposition. In accordance with this, Table V shows that he is the only case whose weekly averages were unaffected by our effort to arouse his interest in the fifth week.

2. *Tapping on a Re-action Key.*

The tests in tapping were intended for a study of their attention and other things, besides that of practice. I shall consider at present only those results that are concerned the more immediately with practice. The apparatus consisted of the reaction key, some dry batteries, a kymograph, a pendulum at first, and later a metronome, for a time-marker, and two DePrez signals. The record on the kymograph drum, then, consisted of the tracings of the individual taps made by the child on the re-action key, together with that of the time-marker, which was set to half second beats. Four groups of tests were made. In all the child was seated at the table with his right arm and hand, with which he tapped, resting comfortably on the table, and facing away from the apparatus. In the first group the tapping was at his natural rate, the child being told simply to tap, all suggestion of any particular rate

being avoided, but he was always promptly urged to go on whenever he stopped altogether. To avoid any sounds of the apparatus suggesting any rate, a pendulum was used for a time-marker instead of the metronome, used later. In these tests each case tapped for a minute a day for four days. A record was taken of every such minute series. In the second group all the conditions remained the same, except that the child was told to tap just as fast as he could, and every possible means of encouraging a maximum rate was constantly employed. This was continued for three days only. The third and fourth groups were intended for practice tests primarily. They consisted of regulated tapping, the metronome being the regulator, and at the same time the time-marker, instead of the pendulum. The child was told to tap in unison with the beats of the metronome. All the apparatus except the button of the reaction key and the metronome was screened from the child, so that he could not see and watch it by turning around. In the third group the metronome was set to half second beats, this being a rate a little slower than the natural rate of tapping of most of them. Five one-minute series were taken each day, with a few minutes between series, and continued for six days. A break of three days followed the fourth, but this did not affect the results noticeably. Records were taken of only the second and fourth one-minute series of each day. One of the unrecorded minute series each day was taken passively, that is, the child's hand was taken and made to tap in exact unison with the metronome. In the fourth group the only change was that the metronome beat at second intervals instead of half second, and the test was continued for only two days. In the regulated tapping it was intended to study the nature and amount of improvement, and the factors that would enter to prevent improvement, as in the previous tests in throwing at the target. In counting the records the number of taps were grouped into five seconds intervals, these being small enough for the practical purpose of determining the amount of improvement. If, then, the child got in the ten taps for each five-second interval, during the third group of tapping tests, the record was regarded as containing no mistakes. Thus in dividing the counts into five-second intervals, there were in each minute series twelve chances to get in the right number of taps. The results of the regulated tapping are given in Table X.

In the first two horizontal columns the average number of taps per five seconds in their natural rate, and the mean variation from that rate, respectively, are given for each case for the sake of comparison with the other figures. In the first vertical column for each case are given the percentages of the number

TABLE X.

		A		B		C		D		E		F		G		H		I		Av.	Av.
Average in natural rate,		17.82		12.90		19.94		12.79		20.19		11.88		17.5		10.78		16.94			
M. V. " "		3.28		2.66		2.19		1.12		2.96		1.32		1.87		.85		.78			
Tap per half sec.	First half,	41.6	1.54	50	1.73	53.33	1.07	68.3	1.05	16.66	3.58	66.66	2.8	66.66	1.25	85	1.22	41.66	1.6	54.36	1.76
	Sec'nd "	25	1.6	16.66	4.2	63.33	2.83	73.3	1.5	5	3.54	65	1.9	76.66	1.21	80	1.33	70	1.77	52.77	2.21
Tap per second.	First half,	41.6	2.86	29.1	3.18	79.1	1.4	79.1	1.4	20.8	2.89	70.8	1.86	—	—	83.3	1.75	79.1	1.80	60.36	2.14
	Sec'nd "	16.6	2	16.6	2.65	45.8	1.23	83.3	1	8.33	2.68	70.8	1.71	—[1]	—	91.7	1.5	70.8	1.29	50.49	1.75
Average,		31.2	2	28.09	2.94	60.39	1.63	76	1.35	10.2	3.17	68.32	2.07	71.66	1.23	85	1.45	65.39	1.62		

of times the correct number of taps were made in the different five-second intervals in the regulated tapping. Thus the number of times A got in the right number of taps, *i. e.*, ten during the first five[2] one-minute series when the metronome beat half second intervals, was 41.6% of the total number of chances he had to get it correct. The second vertical column for each case gives the mean variations in the number of taps from the correct number. The averages below are averages of the figures in the table, and serve only as means of comparing the cases. The results are very irregular, as is seen, and give little information as regards practice. The averages on the right, however, show that their tapping became poorer during the second five one-minute series; that it was best in the beginning of the next group of tests, in which the rate was changed from half second to second taps, and that it dropped to the poorest immediately after that. There is no question but that this is due to the same factor, viz., losing of interest, which mainly determined the curve in the throwing records. With the slight variation in the procedure came a new interest, but this disappeared at once. The main interest in the table, however, attaches to its analysis, which in connection with the general observations made during the test shows what factors entered in determining for each case the percentage of the number of times the right number of taps were made in the five seconds. In watching them during the tapping several factors were found to be prominent in determining the nature of their tapping. The large variations were almost entirely due to their getting

[1] Omitted on account of sickness.

[2] The test was continued for six days, as was stated, but on account of unavoidable omissions on the sixth day for some of them, the results for all cases are those of only the first five days.

tired of it and stopping altogether, by being distracted by something and stopping, or by willfully tapping much too fast. Thus A's mean variation was raised almost entirely through his stopping because he was tired of it and did not like to continue. The same was less true of B, but he also stopped frequently through distractions, and as often willfully tapped too fast. E's variations were high on account of his frequent alternately tapping very fast and then suddenly stopping again, showing apparently an absolute inability to get his attention on the proper rate. F's variations were raised mainly by stopping through distractions, this being a general characteristic of the case. C and I, especially I, seemed to tap mechanically with a quite regular rate independently of where their attention was. In fact I had a strong tendency to tap at his natural rate, and had difficulty in changing it to a slower rate. D, G, and H were the only cases that seemed to keep their attention regularly on the tapping, making few stops, and never purposely tapping too fast. All these factors in the other cases entered, of course, in decreasing the number of times the correct number of taps would be made in the five-second intervals. But it will be remembered that in the regulated tapping the rate was slower than the natural rate for any of the cases, as is seen in the table. To overcome this natural rate was thus a part of the difficulty for all of them in the regulated tapping. The next table will show what relation this tendency to keep to the natural rate, together with the other factors, has borne to their tapping in the regulated series. Table XI is made up from Table X. It gives simply the order in which the cases stand in regard to four things. In the first horizontal column is given the order according to their proficiency in tapping in unison with the metronome. In the second is given their order according to their variations from the correct number of taps for the five-second intervals. In the third is given their order according to their natural rate, the one with the slowest natural rate standing first, etc. The last gives their order according to their variations in their natural rate.

TABLE XI.

	A	B	C	D	E	F	G	H	I
Per cent. correct,	7	8	6	2	9	4	3	1	5
Variations in regulated series,	6	8	5	2	9	7	1	3	4
Natural rate,	7	4	8	3	9	2	6	1	5
Variation in natural rate,	9	7	6	3	8	4	5	2	1

Here it is seen that the order in the first column keeps quite close to that in the others, throughout, for the nine cases. I is an exception in his variations in his natural rate on account of the purely mechanical nature of his tapping, which made

him very regular in the non-regulated series, but it was too fast, and in his attempt to adjust it to the proper rate his tendency to the natural rate is well expressed by the order in which he stands in the first and second columns. G has a high natural rate, but he stands first in general development and his greater ability of attention gives him the rank he has. F's natural rate is close to that of the first group of tests in the regulated tapping, but his great tendency to be distracted raised his variations, while at the same time he ranks fair in the first column because he tapped with good attention during the intervals between distractions. B's natural rate is favorable to the regulated rate, but his great variations, due to the factors mentioned, make him rank low. The other cases need no special comment, for it is seen that their natural rate and their tendency to vary contributed about equally to their proficiency in the regulated series. The general average in the mean variations in Table X does not decrease, and this is due to the fact that whatever practice effect there might be decreasing it, is over-balanced by their becoming tired of the work and thus becoming more irregular through stopping, etc.

The throwing and the tapping tests were the only two that were primarily intended for the purpose of studying the factors that would enter in determining the changes in their proficiency in the work as it was continued. Some of the other tests, however, also furnish evidence on the nature of these factors, but the statement of these results will be postponed until we come to the consideration of the other results of those tests.

C. Attention and Effort.

1. *Tapping on Re-action Key.*

That feeble-minded children are defective in attention and will has been the statement of every observer that has written upon the subject. Indeed, this defect has been regarded so fundamental that Sollier has made it the basis for the classification of all cases of arrested development, and he thus proceeds to classify them into three grades according to the degree of their defective attention. But this is a broad generalization, and too abstract to present any definite picture of concrete instances. Besides, general observation, upon which alone the analysis rests, can make only a very rough and inaccurate quantitative measurement.

The tests grouped under the present heading were aimed at two things mainly. First, to get some sort of measurement of the degree of effort they were capable of putting forth in a particular task. And second, to measure their attention span. Under the first, two sets of tests were made. One consisted in comparing their maximum rate of tapping with their natural

rate. The other determined their association and discrimination time in four different ways. The tapping test has already been described. In the maximum rate series every effort was made to make them increase and keep up their speed, by coaxing, by arousing their rivalry, etc. In the next table the average maximum rate and the average natural rate for each case is given.

TABLE XII.

	A	B	C	D	E	F	G	H	I	AV.
Av natural rate,	17.82	12.90	19.94	12.79	20.19	11.88	17.5	10.78	16.94	15.64
" maximum rate,	18.72	12.85	21.75	17.89	21.95	14.81	16.31	12.83	18.37	17.28
Difference,	.90	-.05	1.81	5.10	1.76	2.93	-1.19	2.05	1.43	1.64

This gives the general averages of the number of taps per five seconds for each case. It is a rather surprising result. For it shows that they are practically incapable of any voluntary effort whatsoever. Perhaps some allowance must be made for the fact that the maximum series was given after the other, and they were probably already getting a little tired of the test. But that too would only show that they are unable to overcome by their own will their disinclination to do a certain thing. The average maximum rate of the average adult normal person is considerably above twice the average in this table, and their average natural rate is just about what an easy-going natural rate of a normal person would be. It is also seen that in a general way the difference between their natural and their maximum rates increases with the grade of general development. A, B, C, and I are the poorest cases, and they stand lowest in their differences. G is the only exception, his difference being negative, although he stands highest of the nine cases in general development.

In close connection with this incapacity for voluntary effort in raising their maximum rate above their natural stands the matter of their fatiguability, and the capacity to overcome the effects of fatigue by effort. Wylie, in a similar test in tapping, finds the difference in the number of taps during the first five seconds and the last five of a forty-five-second series to be small.[1] Hence they apparently show but little effect of fatigue. In a dynamometer strength test he finds their deficiency very great. But he remarks that 'taking the weight and height as an index of muscular development, we conclude that fully three-fourths of the deficiency in muscular power must be due to some central defect, as lack of nerve power, or will power.'[2] In the next table are given my results. In the first vertical column is given the general average of the number of taps of all of the first, second, and third five-second intervals, *i. e.*,

[1]Psycho-Asthenics, Vol. V. 2. [2]*Ibid.*

average number of taps per five seconds for the first quarter of the minute series, etc., for the other three vertical columns. The last vertical column on the right gives the difference between the rates for the first and fourth quarter minute. The averages at the foot are averages of the figures in the table. The first thing of interest in this table is the fact that their natural rate decreased after the first fifteen seconds. It is of course clear that there should be practically no fatigue in normal persons, tapping at this rate. The decrease in rate with these children is undoubtedly due to two factors. One is that their attention tires at once. That is, they cannot keep in mind the idea of keeping up their task. After the first several seconds their mind wanders to other things, and the rate

TABLE XIII.

		1st	2nd	3rd	4th	Dif.
A	Natural rate,	20.42	16.25	17.58	16.58	3.84
	Maximum "	21.78	18.22	15.11	19.11	2.67
B	Natural "	15.50	12.42	13.17	14.02	1.48
	Maximum "	15.33	13.78	13.11	10.50	4.83
C	Natural "	21.66	19.90	19.15	18.23	3.43
	Maximum "	24.67	21.67	21.00	19 67	5 00
D	Natural "	14.25	12.50	12.67	11.25	3.00
	Maximum "	19.44	16.78	18.11	17.22	2.22
E	Natural "	21.83	19.50	19.75	19.67	2.16
	Maximum "	27.67	20 22	20.00	19.89	7.78
F	Natural "	13.00	11.58	11.00	11.94	1.06
	Maximum "	16.57	15.00	14.89	13.11	3.46
G	Natural "	20.17	17.50	17.67	14.67	6.50
	Maximum "	18.56	16.56	14.56	15.56	3.00
H	Natural "	11.83	11.08	10.33	9.83	2.00
	Maximum "	14.78	12.11	12.33	12.11	2.67
I	Natural "	17.75	17.17	16.50	16.36	1.39
	Maximum "	20.78	18.44	17.67	16.67	4.11
Av.	Natural "	17.38	15.32	15.31	14.84	2.54
"	Maximum "	19.95	16.98	16.30	15.98	3.97
Difference,		2.57	1.66	.99	1.14	

consequently drops to that extent. And secondly, they are not able to resist the effect of the very slight degree of muscular fatigue that does enter. To do so would require an increase in effort, and of this they are incapable. That the first factor is present is of course borne out by many general observations. That as a class they cannot attend to anything very long is the statement of every observer, and is the basis of the more general view that a defective attention is their fundamental deficiency. Table XIV will give some idea as to how their attention does last, and how much it drops in this test. That the second factor mentioned was present, that is,

that they were incapable of resisting even a very slight degree of muscular fatigue, the general analysis of the results in Table XIV shows quite well. The maximum rate is, on the whole, only slightly above their natural rate. But the difference between the two rates is greatest at the beginning of the minute series. In the averages for all cases it is seen that it is more than twice as great for the first quarter minute as for any of the other three quarters. By the third quarter the two are practically the same. Now the difference in actual fatigue in the two rates cannot have been great. The rates are only slightly different, and both are slow enough not to permit of much fatigue. Yet to the only very slight difference there could have been they have promptly reacted, by slowing up in their maximum rate faster than in their natural rate. These facts taken together can mean only one thing, viz., that they are almost absolutely incapable of any voluntary effort whatsoever. From this it follows, as the results also show, that there is no such thing with them as genuine, normal fatigue. They can never be made to work hard enough in the first place to make much fatigue possible, and they so promptly react to the slightest degree of it as to shut out its further possibility. A comparison of the poor with the good cases indicates also that the poor have reacted to fatigue more than the latter. As was already seen in Table XII, the poorer cases, A, B, C, and I, increased their maximum rate over their natural rate less than did the others. In Table XIII, the average number of taps the good increased their maximum over their natural rate in the first quarter minute is 3.19. The same average for the poorer cases is 1.81. The average number of taps the natural rate of the poorer cases has decreased in the fourth quarter compared with the first quarter is 2.54. Their decrease for the maximum rate is 4.15. For the better cases these averages are 2.96, and 3.83 for the natural and maximum rates, respectively. But both these figures are too high on account of the exceptionally high decrease of 6.50 for G's natural rate, and the exceptionally high decrease of 7.78 for E's maximum rate. Thus the cases that stand higher in general development have kept up their rate better than the others in both natural and maximum rates, even though they have increased their maximum rate over their natural much more than the poorer cases did.

The tests in regulated tapping gave a rough means of determining during what part of the minute series their attention was best, by showing in what five-second intervals they get in the correct number of taps oftenest. The next table gives these results. In this table are given merely the number of times each case made the correct number of taps for the differ-

ent five-second intervals, from the first to the twelfth. The fig-

TABLE XIV.

	1	2	3	4	5	6	7	8	9	10	11	12
A	4	5	7	6	8	5	6	3	3	2	3	2
B	5	5	6	4	5	4	4	4	3	3	3	5
C	5	10	11	9	8	8	10	7	8	10	6	9
I	7	12	12	10	12	7	9	7	6	7	5	9
Av.	5.25	8	9	7.25	8.25	6	7.25	5.25	5	5.5	4.25	6.25
D	7	8	11	13	11	7	10.	13.	11	11	10	11
E	2	3	1	2	0	3	1	2	1	1	2	2
F	9	11	10	7	10	12	10	10	7	9	10	7
G	1	9	8	8	7	9	5	7	8	9	7	9
H	7	11	11	11	13	12	12	13	12	13	12	12
Av.	5.2	8.4	8.2	8.2	8.2	8.6	7.6	9	7.8	8.6	8.2	8
Gen. Av.	5.22	8.22	8.56	7.78	8.22	7.44	7.44	7.33	6.56	7.22	6.44	7.33

ures are based upon fourteen one-minute series for each case. Thus A, *e. g.*, had fourteen chances to make the correct number of taps for each of the five-second intervals, and got it correct 4, 5, 7, etc., times for the first, second, third, etc., intervals. In dividing the cases into poor and good again, there is one exception in each group in the test. I, although poor in general development, tapped very regularly, as will be remembered, and thus did better in the regulated series. E, although standing much higher, generally, for some reason could not do this test at all. But including the exceptions even, the averages in this table agree with what was to be expected from the preceding tables on fatigue and effort. The general averages for all cases show that their attention falls at least after the fifth five-second interval. The averages are from too small numbers to be very regular, yet in the two groups of cases it is seen that, although there are as high averages for the poorer cases during the first half minute as there are during the first half minute for the better ones, the averages during the last half minute drop decidedly more for the poorer cases. This goes to indicate that although their attention in its maximum may approach that of the better cases, it is less regular, and far less persistent. How much this change during the second half minute is due in both instances to muscular fatigue, and how much is really a fatigue of attention, cannot, of course, be said.

2. *Association and Discrimination Time.*

The means that can be employed in determining association time always involve some form of reaction. For the subject can manifest that he has an association only through speech, or through some other muscular movement. Consequently it is impossible to measure association time directly. The time that we do measure always includes the time that it takes to

give expression to the association. And, more important than this, we have no means of determining how much the particular mode of expression otherwise interferes with the associative process whose time we are attempting to measure. In considering the association time of feeble-minded children, the first thing that we need to bear in mind is the probability that the long association time that our figures will show is due more to their slow way of expressing their associations than to any slowness of the succession of imagery, because of the great lack of effort with which they proceed. For this reason I have classed the following tests under the heading of 'Attention and Effort,' rather than by themselves, although by the method employed, I believe a large part of the source of error mentioned has been eliminated.

Some experiments have been made on the association time of feeble-minded children. Johnson[1] employed the following method: A key word was called and the child was requested, in the written tests, to write down everything for thirty seconds that the word suggested. In the oral tests the suggestions were spoken. In a written test on fifteen children, average 15.8 years, he got an average association time of 8.3 seconds. In an oral test on thirty children, average age 13.3 years, he got an average of 5.35 seconds. On normal children Cattell and Bryant got, by the written method, an average of 4.5 seconds. Johnson got an average of 2.6 seconds for ten normal boys, by the oral method. Wreschner[2] has made a very exhaustive study of the associations of one case, age 22 years, using Sommer's classified list of words, designed for the purpose, for key words. He used the oral method. His main object was a qualitative study of the associations, and only the first association for the key word was recorded. Space will not permit a full statement of his results, but in his average the association time is somewhat lower than Johnson's with the oral method. It is clear, I think, that none of these figures are to be taken as measuring the actual association time. In the written tests the largest part of the time must have been taken by the writing, and when we remember that with feeble-minded children writing is, as a rule, apt to be more of a laborious task than with normals, this becomes still more evident. However, the figures do not lose their value when compared with the results of normals obtained under the same conditions. They are a fairly good measure of the degree of effort that has been put into the task.

In my own tests it was attempted to eliminate as far as possible the source of error that results from the lack of effort with which feeble-minded children proceed in any task. The re-

[1] Psycho-Asthenics, Vol. II.
[2] Allg. Zeitschr. f. Psychiatrie. Bd. 57, 1900.

sults themselves will show best how far this has been successful. The first test consisted in the child naming ten object pictures as fast as he could be made to do so. The pictures were those that had been used for over a month in the memory span test. They were placed upon the table before the child under a card-board cover. When ready the cover was quickly removed, and the child named the pictures as I pointed to them, they being pointed to at a slightly faster rate than he could name them, in order to further prevent his lagging in effort at any time. With the pictures, as in the following tests, ten trials were given to each case, but generally not more than one a day. In order to prevent their becoming weary of the test the days on which the trials were given were scattered at irregular intervals over about two months. The other tests consisted of discrimination-time tests. On twenty-five blank-faced playing cards were pasted five geometrical forms, cut from five different colored papers, so that each form appeared five times, once in each of the colors, and each color appeared five times, once in each of the forms. The colors were standard red, orange, yellow, green, and blue, and the forms a triangle, square, circle, diamond, and oblong, all solid and averaging about an inch in diameter. The first thing consisted in determining the mechanical time; that is, to see how long it would take the child to take hold of each of the twenty-five cards, turn it over, and place it upon the table. The cards were handed to the child as fast as he could take hold of them. The second time the child was requested to sort the cards into five piles, according to color. The third time he sorted them according to form. In all of the tests the time was taken with a stop-watch, and the usual means of encouraging a maximum rate were employed. In the discrimination-time tests three trials were given a day to each child, so that one trial on mechanical time, one on color discrimination, and one on form discrimination, came on the same day. Ten trials in all for each were given to each child, but scattered over two months of time, as in the tests on naming pictures. To parallel these discrimination-time tests with a similar one, the same procedure was repeated during the same two months with twenty-five object picture cards, five each of five different pictures, taken from the ten that were being used in the other tests. The mechanical time was also taken ten times for each child with the picture cards, they being less smooth and not so easily handled. The object of the discrimination tests was, first, to determine the time it would take the child to recognize a color, form or picture and associate it with its proper place on the table. The mechanical time involved in merely taking hold of the cards, turning them over and placing them upon the table

would be the same in all, so that the time in the mechanical time tests could be subtracted from the time in the other tests and obtain the actual discrimination time. Secondly, the tests were made with colors, forms and pictures because it was conceivable that this time might depend much upon the kind of stimulus used. It might be considerably shorter for things with which the child was quite familiar than for others. Table XV gives the results.

TABLE XV.

	A	B	C	I	Av.	D	E	F	G	H	Av.	Gen. Av.
Naming pictures,	1.60	1.30	1.35	1.62	1.47	1.79	1.19	2.03	1.06	1.39	1.49	1.48
Discrim. "	1.69	1.71	1.25	1.46	1.53	1.49	.99	1.69	1.28	1.54	1.40	1.46
" colors,	2.31	2.04	1.85	2.80	2.07	1.30	.90	1.34	1.23	1.29	1.41	1.67
" forms,	—	3.18	—	2.64	2.91	1.45	1.12	2.00	1.37	1.72	1.53	[illegible]
Averages,	1.90	2.06	1.48	2.13	2.00	1.51	1.05	1.78	1.24	1.49	1.46	1.64

These figures express the average time in seconds it took each child to name one picture, discriminate a picture, a color, and a form. A and C could not be taught to sort the cards according to form after they had done it once or twice according to color. For some reason that I could not determine, they seemed not to be able to understand what was wanted, would mix up all the forms when told to sort them, and could not be taught. Consequently the test had to be omitted for these two cases. On account of sickness, C's averages in the second and third horizontal columns are from seven and five trials, respectively, instead of from ten. On account of a partial red-green color blindness of I his average of 2.80 is left out of the general averages. The first thing to be noted about the results is the fact that they are decidedly lower than the lowest average Johnson obtained from children much older. The general average for all cases and all methods is only 1.64 seconds as against 5.35 seconds, the lowest average Johnson obtained. These low figures are perhaps in part due to the constant individual coaxing and encouragement each child received in my tests. But it is undoubtedly much more due to the other differences in the method. The averages are still higher than they would be with normals when the same method is employed, but it is also evident that the source of error resulting from lack of effort in performing the task has not been entirely eliminated. It is not eliminated in the test on naming pictures. And in the discrimination-time test it is not entirely eliminated in that in the mechanical-time tests they dropped the cards practically all on one pile, often hardly taking hold of them at all, while in the sorting tests they had to keep the cards separate in five piles, necessitating taking hold of each card properly and also a slightly greater arm movement. These matters considered, it becomes probable that their actual association time is not so very much longer than that of normals; at least it is evident

that the difference is not nearly so great as might have been supposed from previous results.

An interesting part of the results is the fact that their discrimination time is different accordingly as pictures, colors, or forms were used. The averages for all cases show that it is shortest for the pictures, and longest for the forms. The pictures were chosen as something with which they would be very familiar, they having used them a long time in the memory span test, and because they showed a decided interest in them, the object being to see whether familiarity and interest would have any effect upon their discrimination time. The results show that they did shorten it. Why the discrimination time for form should be longer than that for color is in part accounted for by the fact that their institutional training had laid somewhat more stress upon color training than form training. But another factor enters also in that form can be less easily discriminated in the peripheral field of vision than colors, and this had to be done when the five piles were kept separate on the table by a few inches. In comparing the discrimination time of the poor cases with the better ones again, it is seen that it is longer for the former, being 2.00 seconds in the general averages as compared with 1.46 seconds for the better cases. Furthermore, the difference in picture, color, and form discrimination time is considerably greater for the poorer cases. This fact is in accordance with the previous results in the memory span, in which it was seen that they could remember some pictures decidedly better than others. We shall see the same fact again in an attention span test.

These tests were not of a nature to show practice effect very much. And the element of getting tired of the task was quite effectively ruled out by scattering the tests over a long period.

3. *Attention Span.*

The attention span test consisted in determining how many things the child could see and recognize when those things were presented for a fraction of a second only, so that there was no opportunity for the attention to move from one to the other, but all had to be attended to simultaneously. The things presented were form and color, the same that were used in the discrimination-time tests, except that they were mounted on 6x8 card-boards to fit the apparatus. The apparatus was a large disk tachistoscope, set so that it would expose the form and color cards for something less than a fifth of a second. The cards were arranged in three groups, with five in each. On each of the five in the first group was one form in one color. Those in the second group had each two forms in two colors.

Those in the third group had each three forms in three colors. The combinations were as follows:

		A					B					C		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.t.	O.s.	Y.c.	G.d.	B.o.	B.t.	R.c.	O.c.	G.t	B.d.	R.s.	Y.t.	O t.	R.c.	B.t.
					G.s.	O.d.	Y.s.	Y.o.	R.o.	B.c.	B.s.	R.d.	Y.d	G.s'
										G.d.	G.c.	Y.o.	O.o.	R.o.

A, B, and C = the card groups. 1, 2, 3, etc., = the 6x8 cards on which forms and colors were pasted. R, O, Y, G, and B = red, orange, yellow, green and blue. t, s, c, d, and o = triangle, square, circle, diamond, and oblong. Each of the fifteen cards, excepting 6, was shown once a day to each case for ten successive days, with an interval of three days after the fourth day. To study a practice effect card 6 was shown three times a day instead of once. In the experiment the child was seated at the table with his eyes at about the level of the position of the cards in the tachistoscope. The distance varied from ten to twenty inches, each child being allowed to suit himself, within these limits. Before the child on the table in front of the tachistoscope were placed the forms and colors used on the cards 1 to 15, but mounted on blank playing cards, one on each. Their number was never greater than twelve to fifteen. When all was ready the child was told to watch, his attention being called by tapping the part of the disk behind which the card would be exposed. When his eyes were upon the spot, which could be readily seen by the observer, the disk was turned and the exposure made. The child then picked out the forms and colors he thought he had seen, from those before him on the table.

During the tests it was found that the imagery, in terms of which the child recognized the forms and colors and by which he picked them out, differed very widely with the different cases. Not all knew all the form and color names, but all knew some. A few knew all but could not apply them correctly. Several used the color name in remembering them to pick them out, but none used any form names in this way, so far as I could find out. Thus, each apparently made a different use of the color word image, the form word image, the color visual, and form visual image. A named all the colors correctly, and also the forms, excepting the diamond. He remembered the colors by their word images, the forms probably by visual images. B named all the colors and all the forms correctly, remembered colors by the word images, but not the forms. C knew a few color names but did not always apply them correctly. He knew no form names. Consequently word images probably played no part in his memory and recognition. D used all the color and all the form names correctly, but did not

use the form names in remembering; he probably used the color names somewhat. E named all the colors correctly except blue and yellow. He knew all the form names, but applied them wrongly. Word imagery probably played little or no part in his memory. F named all colors and forms correctly readily, but did not use the form names in remembering. G named the colors correctly, knew all the form names, but applied all but 'round' and 'square' wrongly. It is doubtful whether he used color names in remembering. H named all colors and forms correctly, but did not use form names in remembering. I was considerably red-green color-blind. He knew all the color and form names, but applied none correctly always. The results on the attention span are given in the next table. The figures in this table are the average number of mistakes each case made for each card group.

TABLE XVI.

	A	B	C	I	Av.	D	E	F	G	H	Av.	Gen. Av.
A	.08	.06	.10	.04	.07	.04	.04	.14	.02	.02	.05	.06
B	1.63	1.35	1.75	1.20	1.48	1.20	.83	1.18	.45	1.03	.94	1.21
C	2.50	1.90	2.54	2.70	2.41	1.90	2.14	2.34	1.94	2.08	2.08	2.25
Av.	1.40	1.10	1.46	1.30	1.32	1.05	1.00	1.22	.80	1.04	1.02	

It will be remembered that card group A had five cards, each with one form in one color, and that each of the cards was shown ten times to each case. Thus the .08 for case A is the average number of mistakes he made with one form in one color, in fifty trials with the same. His 1.63 is the average number of mistakes he made with two forms in two colors, etc., for the other cases. In the horizontal B-column, however, the averages are from four cards only, instead of five, the results from card 6 being omitted on account of their being different because it was shown thirty times instead of ten times to each case for practice effect. No corrections have been made in the table for the chance error due to the forms and colors being picked from as small a number as twelve to fifteen. From the figures it is seen that the attention span, under the conditions of the test, lies in the neighborhood of three. Thus in the general average for all cases they have made 1.21 mistakes when four things were presented, two forms in two colors, and 2.21 mistakes when six things were presented, three forms in three colors. The C-card group was clearly entirely beyond them, since they got less than four correct, on the average, out of six. On the other hand, the small error of .06 for the A-card group must, of course, be regarded as the result of occasional accidents, and not as meaning that their attention span was slightly less than two, one form in one color. Comparing the poorer with the better cases, the average number of errors

is greater for the former, the difference being .02, for the A-card group, .54, for the B-card group, and .33, for the C-card group.

Three cases, A, B, and F, made more mistakes in form than in color. Of all the others the reverse is true. However, the differences are not great enough to show any decided preference for one or the other. From the fact that none of the cases used form names in remembering forms, so far as could be determined, and that all of them used color names it might have been expected that most mistakes would have been made with forms. But too many other factors entered to judge what the effect of this could have been.

A more marked influence than that of color as a whole, or form as a whole is seen when the individual colors and individual forms are compared with each other with reference to the number of mistakes that were made with each in choosing it when it had not been shown, and in not choosing it when it had been shown. Table XVII will show that most of the cases had two or more decided color or form preferences. That is, they would choose one color or form wrongly much more frequently than another, or fail to see it more frequently than another. The results are expressed in percentages.

TABLE XVII.

	[illegible]	O	Y	G	[illegible]	Av.	M.V.	t	s	c	d	o	Av.	M.V.
A	33	38	47	24	38	36	6.00	24	25	47	45	58	39.8	10.24
	39	50	18	33	31	34.2	8.24	31	46	[illegible]	38	32	37.4	4.72
B	21	18	8	38	25	22	7.60	21	33	48	18	27	29.4	9.08
	21	34	33	16	18	24.4	7.52	20	33	28	32	35	29.6	4.48
C	27	46	45	34	25	35.4	8.08	21	28	57	17	50	34.6	15.12
	53	26	25	38	36	35.6	8.08	35	33	32	43	25	33.6	4.32
D	23	18	28	30	30	25.8	4.24	23	15	56	12	20	25.2	12.32
	36	36	28	23	13	27.2	7.36	23	15	17	32	32	23.8	6.56
E	23	42	35	24	15	27.8	8.56	20	16	32	20	28	23.2	5.44
	20	30	17	30	33	26.0	6.00	13	38	25	10	30	23.2	9.36
F	31	36	35	13	31	29.2	6.48	39	26	45	27	50	37.4	8.72
	30	40	25	40	15	28.0	9.60	19	54	28	47	23	34.2	11.04
G	14	28	17	15	18	18.4	3.84	20	8	8	5	27	13.6	7.92
	19	16	20	18	14	17.4	1.92	8	13	14	22	12	13.8	3.36
H	21	12	27	30	24	22.8	5.04	14	41	13	20	10	19.6	8.72
	30	38	30	13	15	25.2	8.96	20	14	17	33	20	21.0	5.00
I	60	28	37	15	41	36.2	11.76	16	20	35	30	48	29.8	9.44
	34	40	40	40	29	36.6	4.08	35	33	23	20	28	27.8	5.04
Av.	28.1	28.4	31.0	24.8	27.4			22.0	23.6	37.9	21.6	35.3		
"	30.2	34.4	26.2	27.9	22.7			22.7	31.0	24.9	30.8	26.3		

The first horizontal column for each case gives the percentage of the number of times each color and form was chosen wrongly, chosen when it had not been shown. The second horizontal column for each case gives the percentages of the number of times each was not seen or chosen when it had been shown. The averages are averages of the figures in the table. In the

M. V. columns are given the mean variations from the averages. These mean variations measure the extent to which color and form preferences have been present; they being large, of course, when one or two colors or forms have been chosen wrongly or not seen very much more than the others. The averages at the foot of the table show the relative objective value the different colors and forms have had in the attention span, that is, whether there was anything inherent in any particular color or form that would cause it to be chosen wrongly or overlooked by all cases more frequently than others These averages show that there has been no serious difference between them with reference to this matter. Of the colors blue has been least overlooked, and this was probably due to the fact of its greater contrast on the white background upon which all were mounted. Among the forms the circle and the oblong were chosen wrongly considerably more frequently than the other forms. It is more likely, however, that this was due not to a difference in objective value but rather to a difference in subjective attitude of all the cases towards these forms through associating them with things in which they had greater interest. The oblong was called 'egg-shape' by most of the cases, and the circle a 'ball.' Thus, as a rule, color and form preferences have been quite an individual matter, each case having his own. For particular illustrations, and their extent, the table itself must be studied. It will be seen that in by far the majority of instances in which a color or form has been chosen wrongly very frequently, the same has been overlooked less frequently and *vice versa*. Thus of the ninety instances in the table it is only in twenty-seven of them that both percentages stand above or below the average. The best instances of preferences are found in C and D. Thus D chooses the circle wrongly 56% and overlooks it only 17%, with corresponding averages for form at 25.2% and 23.8%. In comparing the poor with the good cases, with reference to preferences, the exceptions are so great as to make the averages somewhat doubtful. Though it is true that nearly all of the mean variations for the poorer cases are high, and that the lowest mean variations are found with the better cases, there are several very high mean variations with the latter, especially D and F.

The interpretation of color and form preferences in this test must be the same as that of the preferences found to be present in the memory-span test with pictures, and the discrimination-time test with colors, forms, and pictures. The facts are exactly parallel to those of the memory-span test.

The attention-span test afforded some opportunity for a study of practice effect. It will be remembered that card 6, in group B, was shown three times as often as any of the others. The

purpose of this was to see whether, by repetition, they would learn to associate the four things in this card, blue triangle and green square, so that when they saw one they would be certain of the others. Table XVIII gives the results.

TABLE XVIII.

	A	B	C	I	Av.	D	E	F	G	H	Av.
Av. for card 6,	1.63	.90	1.13	1.23	1.22	.63	1.03	1.33	.07	.13	.64
Av. for cards 7-10,	1.63	1.35	1.75	1.20	1.48	1.20	.83	1.18	.45	1.03	.94
Per cent. gain,	0	33	35	-3	16.3	48	-24	-13	84	87	36.4

The figures are again the average number of mistakes made by each case with card 6, in the first column, and with cards 7 to 10, inclusive, in the second column. These averages show that they have learned, to various extents, the combination in card 6. The exceptions to the rule of improvement in I, E, and F are quite unaccountable. But the percentages of gain or improvement for card 6 are decidedly less for the poor cases than for the better. Even taking the large exceptions of E, and F into account, the average percentage improvement for the better cases is 36.4, as against 16.3, for the poorer cases.

In comparing the number of mistakes made in the first half of the test, the first five days, with the number made in the last half, the last five days, some practice effect is seen also. Table XIX gives the results.

TABLE XIX.

	A	B	C	I	Av	D	E	F	G	H	Av	Gen. Av.
First half,	126	107	129	132	124	96	89	110	61	79	87	106
Second half,	117	72	107	90	97	75	84	113	57	70	80	85
Per cent. gain,	7	33	17	32	22.2	22	6	-3	7	11	8.6	15.4

This shows that there has been in this test a considerable improvement with practice. It is, however, not to be taken as a contradiction of results in the other tests, which indicate that their practice curve goes downward instead of rising, as due to their becoming tired of the work. Undoubtedly they also became tired of the present test. But the occasion for improvement was greater in this test than in the throwing and tapping tests, enough greater to overbalance the effect of the other factors. The table also shows that the amount of improvement for each case has been more dependent upon his proficiency in the beginning than upon the general grade of the case. The poorer cases have improved much more, on the average, than the better ones. In one instance this can be accounted for by direct observation. Case I made 132 mistakes during the first half and only 90 during the last half. This was due to the fact that at first he so frequently chose forms of the same color. Thus in the C-card group, in which three forms in three colors

were shown at a time, he would see one of the three colors and then pick out the required number of forms in the color he had seen, resulting in a large number of mistakes. This he finally learned not to do, and consequently his great improvement in the number of mistakes made during the last half of the test. As for the others, it is possible that it took the poorer cases longer to learn that never more than one of the same color or form was shown at a time. It is true at least that most of the better cases learned this at once. And this once learned, the occasion for improvement was decidedly lessened.

D. Domino Discrimination Test.

In general, in the discrimination of elements in a complex phenomena more factors entering into general ability are involved, perhaps, than in most any other kind of task. To this extent the ability to discriminate should be a fairly good measure of the general grade of the case. In the present test it was aimed to get a simple task of discrimination, and to supply the conditions that would make it possible to determine what factors entered in making discrimination good or poor. Two sets of double-nine dominos were used. Each set was divided into five series of ten each, so that those with the least number of spots were in the first series, and those with the most spots in the fifth. The series were used in their order from first to fifth. In the test the ten in a series from one set were placed in a small circle on the table before the child. One from the same series from the other set was placed in the centre of this circle and the child told to find the one like it in the circle as quickly as possible. The usual encouragement to go fast was employed. As soon as the child picked up the right one the one in the centre was replaced by a second, and he was told to find that one, etc., until the series was completed. If he picked the wrong one he was told that it was wrong, and the one taken was recorded. The time that it took him to complete a series of ten was taken with a stop-watch. Each series of ten was given to each case four times, unless he made no mistakes at all in the first two trials. If he got them all correct the first two times it was taken that he could discriminate all in that series perfectly. There were a few exceptions in this procedure which will be noted in connection with the statement of the results.

In the next table are given the results on the average number of mistakes each case made in each series, and the average length of time it took him to complete that series. The first vertical column for each of the five series of ten dominos for each case gives the average number of mistakes he made for the respective series. The second vertical column

TABLE XX.[1]

	I.		II.		III.		IV.		V			
	M.	T.	M.	T.	M.	T.	M	T	M.	T.	AV.	AV.
A	1.5	——	2	6:10	.75	7:00	1	7:01	1.5	14:24	1.35	8:39
B	0	3.25	.5	4:21	1.25	2:29	.5	3:03	0	3:38	.45	3:23
C	3	——	5.75	6.17	2.50	6:04	5	4:05	——	——	2.94	5:29
I	2.75	4:33	4.00	6:38	1.75	6.07	3.25	4.05	2.0	6:09	2.75	5.38
Av	1.44	3:59	3.06	5:52	1.56	5:20	1.31	4:34	1.17	8.04	1.87	5:34
D	0	——	0	1:45	0	2:20	0	2:53	.5	3:41	.10	2:40
E	.25	——	.25	2:32	0	3:01	.5	3:33	0	3:08	.18	3:04
F	0	——	.5	3:28	0	3:02	.5	4:20	2.0	3:47	.60	3:39
G	0	1:25	0	2:13	0	2:10	0	2:35	0	2:35	0	2:12
H	0	——	0	2:38	0	2:53	0	3:24	3.0	4:06	.60	3:15
Av.	.05	——	.15	2:31	0	2:41	.20	3:21	1.10	3:27	.30	2:58
Gen Av.	.65	——	1.71	4:12	.78	4:01	.76	3:58	1.14	5:46	1.09	4:16

for each of the five series gives the average time it took each case to complete the series. Thus in the first series B made no mistakes, and it took him three minutes and twenty-five seconds, on the average, to go through that series once. It can undoubtedly be taken safely for granted that the normal child of their age would make no mistakes at all in discriminating dominos. The first point of interest, therefore, is that these children do make mistakes. And, secondly, the number of mistakes they make runs quite closely parallel with their degree of general development. The average number of mistakes made by the four poorer cases is 1.87, for the better cases it is only .30. Again, the time it takes them to go through a series of ten in this way is also closely proportional to the degree of general development, the general averages being 5:34 for the poorer, and 2:58 for the better cases. The best of the nine cases, G, has made no mistakes and has also the shortest time, 2:12.

A study of the character of their mistakes is more instructive. They fall into two general classes. By far the majority of mistakes were due to their overlooking one end of the block. They would get one end correct, and in the recognition of this much would forget about the other end. A much smaller number of mistakes was made through choosing by general appearance, instances of real inability to discriminate. Thus, they would fail to discriminate between a four and a six, a five and a seven, an eight and a nine, etc., on account of their similarity of appearance.

[1] It did not occur to me at once that it would be valuable to take the time it took them to go through a series, consequently no record was kept of this at first. For C the fifth series was omitted on account of sickness.

Summary.

1. They have a very great lack of persistent effort and attention. They are distracted both by external stimuli, things in their surroundings, and by their own imagery and motor habits. (General description of cases, especially cases A, B, and F.)

2. In relating things from memory they mingle facts and imagination, probably as a result of their effortless thinking and a tendency to follow their spontaneous suggestions. (Results from general orientation questions, p. 402.)

3. The memory span with pictures lies between two and three, and changes with the grade of the case. (Table II.)

4. A high memory span for pictures is not correlated with great memory permanency through an interval of several weeks. (Tables I and II.)

5. They show decided memory preferences, remembering some things much better than others. The degree of memory preference changes with the grade of the case, being greater for the poorer ones. With the method employed, the pictures that are forgotten most are chosen wrongly least, and those that are forgotten least are chosen wrongly most. (Tables III and IV.)

Memory preferences are probably due to differences in interest for the different things. (p. 412.)

6. In throwing at a target their practice curve goes down after the second week (Table V) through a decreasing interest in the work, and rises again when that interest is artificially aroused. (Table VI.)

7. The amount of daily variations in the throw for each week runs parallel with the quality of the throw, correlating high daily variations each week with good throwing, and low daily variations with poor throwing. (Tables IX and V.)

Daily variations are due to changes in the daily disposition. From this (6 and 7) it appears that a favorable disposition does not alone affect the quality of their work in a particular task (their surplus energy is expressed in other directions), but does so only when interest in the particular task is aroused, and, secondly, that interest can be aroused only when the general disposition is favorable. (pp. 419-420.)

8. Most cases show a constant error, throwing more in one quadrant of the target than in another, and, with most, this constant error decreases with practice. (Table VII.)

9. The regularity of their throw increases with practice; they miss the whole target less after a while, and also hit the centre less after a while than at the beginning. (Table VIII.)

10. In a minute series of tapping on a re-action key in uni-

son with a metronome beating half or whole second intervals, their practice curve goes down after the first day. (Table X.)

This decline is due to a lowering of interest. (p. 422.)

11. they get in the right number of taps slightly over half the time, when the taps are grouped for five second intervals. (Table X.)

12. In general, those whose natural rate of tapping was nearest the regulated rate, and whose tendency to vary their natural rate was least, showed the greater ability to follow the regulated rate correctly. (Table XI.)

13. The factors that entered in making them fail to keep up the regulated rate of tapping are, (a) inability to keep up the effort, (b) distractions by being attracted by things in their surroundings, and by their own irrelevant imagery and motor habits, and (c) inability to overcome their natural rate of tapping. (p. 422 and Tables X and XI.)

14. Their average maximum rate of tapping is only slightly above their average natural rate, 1.64 taps per five seconds. This difference increases with the grade of the case. Table XII.)

15. Both their natural and their maximum rates drop after the first fifteen seconds, and the two are practically alike by the third fifteen seconds of a minute series. (Table XIII.)

16. In the regulated tapping they do best after the first five seconds, and poorest during the first five seconds and the last half minute of the minute series. This tendency to do poorer during the last half minute is greatest for the poorer cases. (Table XIV.)

From this (14, 15 and 16 especially) it follows that they are almost absolutely incapable of any genuine voluntary effort in a task that they dislike, and that normal fatigue under such circumstances is impossible with them. (pp. 424-428.)

17. Their average association and discrimination time with the methods employed is 1.64 seconds. (Table XV.)

18. This time varies very much with the method emploedy. (p. 428-429 and Table XV.) It is shorter for things with which they are more familiar and have the greater interest, shorter for familiar pictures than for colors, and shorter for colors than for forms. It changes with the grade of the case, as does also the difference for the different methods. (Table XV.)

The time obtained with any method is probably much too long, and does not express the real association time because of the lack of effort with which they proceed in any test. (p. 429.)

19. Their attention span for form and color, and with an exposure of one fifth to one sixth of a second, lies between two and three. It increases with the grade of the case. (Table XVI.)

20. Making more color than form, or more form than color mistakes is an individual matter with each case. Four cases made more color than form mistakes, five more form than color mistakes. (p. 435.)

21. They have color and form preferences, choosing some wrongly more than others, and not seeing some oftener than others. In most instances the colors and forms that are chosen wrongly most are also those that are not seen least, and those that are chosen wrongly least are those that are not seen most. (Table XVII.)

The explanation for this is the same as that for memory preferences for pictures. (p. 436.)

22. Their attention span is raised with practice through their learning the combinations of forms and colors presented (Table XVIII), and probably also in other ways (Table XIX). Their ability to learn the combinations increases very much with the grade of the case. (Table XVIII.) Their general improvement is dependent more upon their lack of proficiency in the start, and is greatest for the poorer cases. (Table XIX and p. 437.)

23. They cannot discriminate dominos from each other by the number and arrangement of spots, at first, but learn to do so in time. The number of mistakes they make, and the time it takes them to match a given number varies very much with the grade of the case. (Table XX.)

24. The character of their mistakes falls into two classes: (a) overlooking one end of the block, more frequent, and (b) failing to discriminate in cases of similarity of general appearance, less frequent. (p. 439.)

The present investigation was undertaken at the suggestion of Prof. E. C. Sanford. It is a pleasure to acknowledge my indebtedness to him for constant advice and many valuable suggestions. Also to Dr. Alexander F. Chamberlain, Acting Assistant Professor of Anthropology, Clark University, for making the physical measurements of the cases for me; to Dr. J. W. Slaughter, Docent in Æsthetics and the Philosophy of Evolution, Clark University, for helping me in giving the tests; to Dr. Walter E. Fernald, Superintendent of the Massachusetts School for Feeble-Minded Children, for permission to work on the cases, and for the use of his fine special Library; to Dr. Wallace and Dr. Ladd, physicians of the institution, for selecting representative cases for me; and to matrons and attendants of the institution for helping me in various ways.

Appendix and Bibliography.

The literature on arrested development is voluminous. I

have not attempted to give any statement of it, and shall not do so now. In 1891 Sollier writes in the preface to his "Psychologie de L'idiot et de L'imbecile" as follows: "The bibliography on idiocy, very poor in France, very rich, to the contrary, in America and England, consists especially of documents on the causes, the classifications, physical signs, the pathological anatomy, and education of idiots. Men have concerned themselves but little with the psychological side, or have repeated what has been often noted." Speaking of his own book he says: "It is the first of the kind, to our knowledge, that has been attempted." Since Sollier's writing much, indeed, has been published on their psychology; far too much, in fact, to improve the disposition of those who attempt to make use of the bibliography. For Sollier's criticism on the character of the psychological literature still holds true. Some books, quite a list of monographs, and many articles on the psychology of arrested development have appeared during the last ten years. But, with a few exceptions, it may be said of all of them that they are based upon general observations only, and deal with repetitions of a relatively few facts that can be readily observed by any one, or that have been frequently stated. It is not my intention to depreciate the value of these observations; they are undoubtedly valuable. But they are not the results of a method that can take us very far into the real science of this branch of mental pathology. The time has come in this field, too, for general observation to take a subordinate place to the more refined procedure of experimentation. Upon the basis of its success and its results we both feel the need, and can judge somewhat the possibility of experimental study. Some experimental work has been done. But it is very little, and the method has hardly as yet seen its beginning in this field. Most of its results have been quoted, or referred to above; the whole is not sufficient to justify a review.

I shall not attempt to give a complete bibliography on all the phases of the subject. Such would be quite useless on account of its very cumbersomeness. But for the sake of keeping the literature somewhat in view, references are given, first, to the larger bibliographies and then to the special works arranged chronologically.

Index Catalogue of the Library of the Surgeons-General's office. U. S. Army. Vol. VI, 1885, pp. 775-782; and Vol. VII. (Second Series), 1902, pp. 816-827.

Index Medicus. Vol. I, 1879, to Vol. XXI, 1898-'99; and Vol. I, 1903. References to the different phases of mental and neural pathology of arrested development will be found *passim*.

Bibliographischer Semesterbericht der Erscheinungen auf dem Gebiete der Neurologie und Psychiatrie. Vol I, 1895, to Vol. IV, 1898. References will be found *passim*.

Jahresbericht über die Leistungen und Fortschritte auf dem Gebiete der Neurologie und Psychiatrie. Vol. I, 1897, pp. 1218-1219. Vol. II, 1898, pp. 1167-1169. Vol. III, 1899, pp. 1097-1098. Vol. IV, 1900, pp. 945-946. Vol. V, 1901, pp. 865-866. Gives digests of the more important articles, etc.

Psychological Index. No. 1, 1894. 'Insanity, Idiocy, and Imbecility.' Nos. 1214-1260. No. 2, 1895, do., Nos. 1256-1305. No. 3, 1896, do., Nos. 2017-2079. No. 4, 1897, do., Nos. 2237-2321. No. 5, 1898, do., Nos. 2255-2388. Nos. 6, 1899, do., Nos. 2344-2451. No. 7, 1900, 'Idiocy, Imbecility, etc.,' Nos. 21-93-2201. No. 8, 1901, 'Idiocy, Imbecility, and General Paralyis,' Nos. 2402-2464. No. 9, 1902, do., Nos. 2074-2110.

L'année psychologique. Vol. I, 1894, *passim*, Nos. 1-1217. Vol. II, 1895, 'Aliénation, Idiotie, et Imbécilité,' Nos. 1256-1305. Vol. III, 1896, 'Insanité, Idiotie et Imbécilité,' Nos. 2017-2079. Vol. IV, 1897, do., Nos. 2237-2331. Vol. V, 1898, do., Nos 2255-2388. Vol. VI, 1899, do., Nos. 2344-2451. Vol. VII, 1900, 'Idiotie, Imbécilité,' Nos. 2193-2201. Vol. VIII, 1901, 'Idiotie, Imbécilité et Paralysie générale,' Nos. 2402-2464.

Neurologischer Centralblatt. Beginning with Vol. 20, 1901, this gives a monthly, or bi-monthly classified bibliography, including sections with references on mental and neural pathology of arrested development.

Only a small percentage of the literature is psychological. During the last few years methods of training, and pedagogical principles to be applied in rearing these defectives have received a large amount of attention; perhaps an undue amount. The following references include books, monographs, and some of the more important articles concerned with their psychology and pedagogy. They are based upon general observations, and are written for the most part for superintendents, physicians, and instructors in the special institutions, and for parents.

BOURNEVILLE. Recueil de memoirs, notes et observations sur l'idiotie. Paris, 1891.

SOLLIER. Psychologie de l'idiot et de l'imbecile. Paris, 1891.

UFER. Das Wesen des Schwachsinns. Langensalza, 1892.

TRUPER. Psychopathische Minderwertigkeiten im Kindesalter. Gutersloh, 1893.

VOISIN. L'idiotie, hérédité et dégénérescence mentale, psychologie et education de l'idiot. Paris, 1893.

The Feeble-Minded Child and Adult. A Report on an Investigation of the Physical and Mental Condition of 50,000 School Children, with Suggestions for the better Education and Care of the Feeble-Minded Children and Adults. London, 1893.

CRAMPE. Ueber zwei Fälle von Imbecilität. Berlin, 1894.

SEGUIN. Rapport et mémoires sur l'education des enfants normaux et anormaux. Paris, 1895.

SHUTTLEWORTH. Mentally Deficient Children. Their Treatment and Training. London, 1895.

DILLNER. Ergebnisse ärztlicher Untersuchung schwachsinniger Kinder und ihre Bedeutung für den Lehrer. Zeitschr. f. d. Behandl. Schwachsin. u. Epilept. 1896, n. F. VII. Also Med-pädagog. Monatschr. 1897; 49, 89, 119.

KREISLSHEIMER. Ueber Idiotie und Imbecilität. Strassburg, 1896.

PETERSON. The Psychology of the Idiot. Proceed. of Am. med-psyc. Assoc. Utica, 1896.
KALISCHER. Was können wir für den Unterricht und die Erziehung unserer schwachbegabten und schwachsinnigen Kinder thun? Berlin, 1897.
MÖLLER. Ueber Intelligenzprüfungen, ein Beitrag zur Diagnostik des Schwachsinns. Berlin, 1897.
REINKE. Die Unterweisung und Erziehung schwachsinniger Kinder. Berlin, 1897.
IRELAND. Mental Affections of Children; Idiocy, Imbecility, Insanity. London, 1898.
LIEBMANN. Die Untersuchung und Behandlung geistig zurückbleibener Kinder. Berlin, 1898.
BERKAN. Ueber die angeborenen und früh erworbenen Schwachsinn. Braunschweig, 1899.
FUCHS. Schwachsinnige Kinder, ihre sittliche und intellectuelle Rettung. Eine Analyse und Charakteristik, nebst theoretischer und praktischer Anleitung zum Unterricht und zum Erziehung schwachsinniger Naturen. Gutersloh, 1899.
KRAEPELIN. Psychiatrie. Ein Lehrbuch für Studirende und Aerzte. II, Band. Klinische Psychiatrie. pp. 573-601. Leipzig, 1899.
LIEBMANN. Geistig zurückbleibener Kinder. Archiv f. Kinderkrankh. Bd. XXVII, H, 1-2, 1899.
SCHENKER. Beobachtungen an schwachsinniger Kinder mit spezieller Berücksichtigung der Aetiologie und Therapie des Schwachsinns. Aran, 1899.
SIOLI. Referat über die Imbecillität. Neurol. Centrallblat, 1899.
SUTHERLAND. Mongolian Imbecility in Infants. Edinb. Med. Journ., 1899.
BUCHHOLZ. Ueber die Aufgaben des arztlichen Sachverständigen bei der Beurtheilung Imbeciller. Allg. Zeitschr. f. Psychiat., 1900.
LIEBMANN. Vorlesungen über Sprachstörungen. Uebungstafeln für zurückbleibene Kinder. Berlin, 1900.
STÖRRING. Vorlesungen über Psychopathologie in ihrer Bedeutung für normale Psychologie mit Einschluss der psychopathologischen Grundlagen der Erkenntnisstheorie. pp 380-400. Leipzig, 1900.
WEYGANDT. Die Behandlung idiotischer und imbeciller Kinder in ärztlichen und pädagogischer Beziehung. Wurzburg, 1900.
DEMOOR. Die anormalen Kinder und ihre erziehliche Behandlung im Haus und Schule. Altenburg, 1901.
LAQUER. Die Hilfschulen für schwachbefahigte Kinder, ihre ärztliche und sociale Bedeutung. Wiesbaden, 1901.
LIEBMANN. Sprachsörugen geistig zurückbleibener Kinder. Abhdlg. aus dem Gebiete der padagog. Psychol. u. Phy., 1901.
MAUPATE. Langage chez les idiots. Ann. médico-psychol., 1901, 35, 225, 387.
NOYES. An Introduction to the Psychological Study of Backward Children. N. Y. Med. Journ., 1901.
SINELL. Geistig zurückbleibener Kinder und ihre Behandlung. Aerztlicher Verein zu Hamburg. Sitzung von 2 Juli, 1901.
DOLL. Aerztliche Untersuchungen aus dem Hilfschule fur schwachsinnige Kinder zu Karlsruhe. Karlsruhe, 1902.
LAQUER. Ueber schwachsinnige Schulkinder. Sammlung zwangloser Abhandlungen aus dem Gebiete der Nerven- und Geistes-Kranken. 1902.
LIEBMANN. Die sprachliche Entwicklung und Behandlung geistig zurückbleibener Kinder. Zeitschr. f. päd. Psychol., Pathol. u. Hygiene, 1902, IV, 2.

TRÜPER. Die Anfänge der abnormen Erscheinungen im kindlichen Seelenleben. Altenberg, 1902.

The results of the purely experimental work that has been done will be found in the following references:

GALTON. Notes on Prehension in Idiots. Mind, 1887.
JOHNSON. Contribution to the psychology and pedagogy of feeble-minded children. Psycho-Asthenics, Vols. I, 4, II, 1, 2, 3.
LOBSIEN. Einige Untersuchungen über das Gedächtniss bei Schwachbefähigten. Die Kinderfehler. Zeitschr. f. Kinderforschung. Bd. VIII, H. 4, 1903.
KELLY. Psychophysical Tests of Normal and Abnormal Children. A Comparative Study. Psyc. Rev., Vol. X, 1903.
WYLIE. Taste and reaction time of feeble-minded. Psycho-Asthenics, Vol. IV, 3.
A study of the senses of feeble-minded. *Ibid.*, IV, 4.
Memory of feeble-minded. *Ibid.*, V, 1.
Motor ability and control of feeble-minded. *Ibid.*, V, 2.
HELLER. Ermüdungsmessungen an schwachsinnigen Schulkindern. Weiner med. Presse, Nos. 11, 12, 13, 1899.
WRESCHNER. Eine experimentelle Studie über die Association in einem Falle von Idiotie. Allg. Zeitschr. f. Psychiat., Bd. LVII.

LITERATURE.

The First German Congress for Experimental Psychology was held at the little town of Giessen from the 18th to the 21st of April. Its numerous attendance was derived from very varied professions; psychologists, philosophers, psychiatrists, physicians, surgeons, philologists, teachers and clergymen, all seemed to find in the present topic one common meeting ground. Although the Congress was national and proceedings were confined to the German tongue, nevertheless representatives were to be seen and heard, not only from Austria and Switzerland, but also from France, England, Norway, Sweden, Holland, Russia, and even from the more remote United States, Canada, Egypt and Japan.

An agreeable feature of the meeting was its remarkably business-like character. The spiritualism and other "occult" phenomena in evidence at the previous international Congresses had disappeared from the programme; contention as to the primary method of psychological research had given way to a frictionless co-operation from all sources; visionary speculations had been wholly replaced by simple exposition of observed facts and explanatory theories. This satisfactory tone must be credited in large measure to the energetic steps of the managing committee, who had restricted discussion to experimental work and membership to such persons as had already published researches of scientific value.

The great wealth of subject-matter precludes attempt in our limited space at any systematic description; we must content ourselves with brief indication of a few salient features. As usual, the largest share of attention fell to the sensory functions, these obviously constituting the region most readily accessible to experimental treatment. A long and important paper was read by G. E. Müller on color-vision, advocating Hering's theory but in a modified and much more elaborate form; the processes in the retina itself were fundamentally opposed to those in the adjoining afferent nervous apparatus. Ebbinghaus discussed some familiar visual illusions, stating that he had found their exact counterpart in the sense of touch also, so that they could not be due to peculiarities in any of the peripheral organs or in the subcortical co-ordination of movements, but must arise from purely intellectual adaptation (Einstellung). Another favorite topic was Memory; in this sphere, we were introduced to a new mathematical prodigy, Dr. Rückle, who, among many other feats, far surpassed all previous record by memorizing in thirteen minutes a series of no less than 204 figures. Miss Gordon (United States) produced some experimental evidence to the effect that—contrary to the usual opinion—neither pleasant nor unpleasant impressions are remembered any better than indifferent ones. Claparède propounded a new theory of sleep; it was no longer to be regarded as a mere cessation of function in consequence of exhaustion, poison, etc., but rather as a positive reflex occurring instinctively in order to obviate such exhaustion. Weygandt had demonstrated upon himself the practically interesting fact, that a short sleep will perfectly renew capacity for easy intellectual performances, whereas much longer repose is indispensable to restore

functions which demand greater effort of attention. Henri related his experiences in conjunction with Binet as regards "individuality;" he enumerated the various brief mental tests which they had employed for this purpose; all, however, had proved unsatisfactory, and now they could only recommend long systematic investigation of each subject. The present writer sketched out some general improvements in the method of calculating psychical correlations. Kulpe read a valuable paper on Abstraction, showing experimentally its paramount rôle in all apperceptive mentation. The youthful experimental science of Testimony (Aussage) was represented by Stern and Fräulein Borst, who dealt particularly with the different reminiscent accuracy of things heard as compared to things seen, of written testimony as compared to oral, and with the comparative reliability of men, women and children; above all, they pointed out the need that children should be taught to testify. Other papers were read—many of them very important—by Schumann, Guttmann, Tschermak, Benussi, Stern, Struyken, Alrutz, Heymans, Wreschner, Ranschburg, R. Müller Eisenhans, Ach, Martius, Ettlinger, Groos, Siebeck, Marbe, Ament, Lay, Exner and Watt. Several who had promised contributions, including Stumpf, Meumann, and Ziehen, had unfortunately been prevented from attending.

The other and at least equally interesting part of the proceedings consisted in an exhibition of apparatus. Martius showed an arrangement for transmitting light rays in exactly measurable quantity and duration. Three new tachistoscopes were presented, each with a special advantage; that of Erdmann and Dodge brought the whole field to view with perfect simultaneousness; in Schumann's, the object to be seen was immediately followed by a bright light, which destroyed the after-image and thus secured real momentariness of vision; while Wirth's mirror permitted instantaneous change of any desired portion of the regarded card (or other optical stimulus). Wirth, Ranschburg and Alber exhibited instruments for exposing a number of syllables, figures, colors, etc. in continuous succession, as a test of perception or memory. Zeiss showed a new stereoscope with micrometer. Stern's Tonevariator proved able to demonstrate beats, difference-tones, etc., with unusual distinctness. Spearman's monochord admitted adjustment down to 1/10 v. d.; his æsthesiometer, having a third point at 45° to the normal pair, rendered it possible to apply single stimuli to any surface *perpendicularly*. Struycken had constructed a valuable instrument for measuring auditory acuteness in micro-millimeters. Sommer demonstrated a variety of ingenious clinical inventions: one of them, on being attached to the patient's pulse, translated the beats into musical tones whose rhythm varied characteristically with every psychic disturbance; another graphically registered the smallest movement of arm or leg in any direction, and curves thus obtained from patients with dementia præcox, alcoholism, etc., presented in each case readily distinguishable symptoms. Many other useful apparatus, photographs, statistical table, and reports were laid out for inspection.

The proceedings closed by founding a permanent national Psychological Society. C. SPEARMAN.

L'Année psychologique, publié par A. Binet avec la collaboration de H. BEAUNIS, V. HENRI et TH. RIBOT, Vol. X. Paris, Masson et Cie. 1904. Price 15 f.

This volume contains among the other original articles by Prof. Binet: the first, the leading article of the volume, "*La création littéraire*," a psychological portrait of M. Paul Hervieu; a Summary of

the Work Undertaken by the Société de psychologie de l'enfant; On Questions of Cephalometrical Technique; and on Graphology and its indications with regard to sex, age and intelligence. The other original articles are by Lecaillon, on the Biology and Psychology of a Spider (*Chiracanthium cornifex*); by Bourdon and Dide on a Case of Continuous Amnesia with tactile asymbolia, complicated with other troubles; by Larguier des Bancels on Methods of Memorization; by H. Michel on Spencer and Renouvier; and by Zwaardemaker on the Sensibility of the Ear to Sounds of Different Pitch. These are followed by the usual sections of general and special reviews and the bibliography for 1903.

The list of original articles above gives some hint of a widening of the field of the *L'Année* of which the editors make more definite announcement in a prepatory note. *L'Année* will publish in future every year or every two years, as may be required, general bibliographical and critical reviews covering literature in fields adjacent to that of psychology, and in carrying out this plan the editors have secured the assistance of the following distinguished savants: For *Cytology*, Hennegnay; *Anatomy of the Central Nervous System*, van Schuchten; *Physiology of the Nervous System, etc.*, Fredericq; *Pathology of the Nervous System, etc.*, Grassel and Pitres; *Mental Pathology*, Simon; *Anthropology*, Deniker; *Sociology*, Durkheim; *Criminology*, Lacassagne; *Psychology of Children*, Madam Fuster, *Pedagogy of Normal Children*, Blum; *Pedagogy of Abnormal Children*, Demoor; *Ethics and Philosophy*, Bonnier, Boutroux, Leuba, Molapert, Metchnikoff and Poincaré.

This number though of the usual form and appearance bears the imprint of a new publisher, Masson et Cie, 120 Boulevard Saint Germain, Paris.

Le Comte de Gobineau et l'Aryanisme Historique, par ERNEST SEILLIÈRE. Plon-Nourrit et Cie, Paris, 1903. pp. 450. (La Philosophie de l'Impérialisme, I.)

This is a pious attempt by a discriminating but loyal pupil to sum up the unique views of Count de Gobineau some twenty years after his death. He has prefixed a brief account of his life which he divides into three periods: the theoretical, the Asiatic and the ascetic. In the first he produces his essay on the inequality of the human races which he divides into three the white, the yellow and the melanian, the former being incalculably superior and who must be served by the other two. Only the Aryans are rapidly developing and of these he seems to think the Germans the best. The impending future solidarity which will reorganize society under Aryan leadership is his goal. In the next period he becomes not only orientalized but almost a mystic and cabalist. The third period was greatly dominated by his relations with Richard Wagner. It would be difficult to say which exerted the greatest influence upon the other. Both co-operated for some time as contributors in the Bayreuth Blaetter.

In Search of a Siberian Klondike as narrated by Washington B. Vanderlip, the chief actor, and herein set forth by Homer B. Hulbert. The Century Co., New York, 1903. pp. 315.

This is a description of an interesting Kamchatkan excursion with dog sledges and various adventures with drifts and blizzards, and has copious illustrations.

La Société Japonaise, par ANDRÉ BELLESSORT. Perrin et Cie, Paris, 1904. pp. 412.

This is a chatty book of a pneumatic writer who has three times

visited Japan and writes in a rather captivating way on the relations of parents to their children, the religious spirit, imagination, on women and love, and on the new society.

On the Threshold of Central Africa, by FRANÇOIS COILLARD. Tr. from French and ed. by Catherine Winkworth Mackintosh. 2d ed. American Tract Society, New York, 1903. pp. 663.

These are simply leaves from pages of a French missionary journal during the last twenty years, describing pioneering among the Barotsi of the upper Zambesi. It is essentially personal narrative and gives a very interesting account of the savages among whom this devoted man labored. While his methods may often be questioned, his sincere interest and devotion to the savages among whom he labored is beyond all praise.

A History of the Colony of Sierra Leone, Western Africa, by J. J. CROOKS. Browne and Nolan, Dublin, 1903. pp. 375.

The author has gone to sources where he could, although the records of the early history of the colony are meagre and the state papers of the last seventy years are not yet open.

China; Past and Present, by EDWARD H. PARKER. E. P. Dutton and Co., New York, 1903. pp. 424.

The author is professor of Chinese in Owens College and writes here a comprehensive book comprising historical and statistical matter, account of the boxers, the religion of China, imperial power, foreigners, mandarin or officials, celestial peculiarities, politics, and the "seamy side" under which he includes punishments, infanticide and slavery.

Au Pays Moï, par MARQUIS DE BARTHÉLEMY. Plon-Nourrit et Cie, Paris, 1904. pp. 255.

The writer made an extensive trip in Cochinchina and Cambodia, especially along the region of the Dgambia mountains. His survey was essentially a military one, but he gives a number of interesting pictures and many characterizations of the people and their customs, especially those of the Mois and the Stiengs.

India; Past and Present, by C. H. FORBES-LINDSAY. Vol. I, pp. 320; Vol. II, pp. 338. H. T. Coates and Co., Philadelphia, 1903.

These volumes are an interesting description of the most salient points and monuments in India by a man who has been connected with this country by birth, and gives an account of its legendary and subsequent historical periods, its customs, manners, etc., all copiously illustrated.

Die Frauen auf Java, von C. H. STRATZ. F. Enke, Stuttgart, 1897. pp. 134.

For more than five years the author was the first gynecologist in Java. Here following the example of his great master, Carl Schroeder, he undertook to do scientific work. He describes native operations, some peculiarities of formation and gives a mass of material which it must be admitted is not all peculiar to Java.

Die Heimat der Indogermanen im lichte der urgeschichtlichen Forschung, von MATTHAEUS MUCH. Hermann Costenoble, Berlin, 1904. pp. 421.

This is a second and enlarged edition which treats of tools and weapons in the early stone age, geometric and colored decorations of pottery, especially spirals, has an interesting chapter on amber, dis-

cusses the great stone graves and caves, has a brief chapter on culture plants, and discusses more at length the dog, sheep, goat, pigs, cattle and horse. The two concluding sections are on race and the geographical and physical constitution of home and its influence upon inhabitants.

The Diary of a Turk, by HALIL HALID. Adam & Charles Black, London, 1903. pp. 269.

This is written by a Turk from the Turkish point of view and with the greatest frankness. The author was born in Angora, Asia Minor, was trained as a child at school and in the harem of which later he gives a very interesting account. Later he went to Constantinople to pursue his studies and selected one of the hundred schools there, choosing at last the profession of law. Among the best chapters in the book are those that describe the school methods, the curriculum of the law school. Until he was nearly through this he spoke no language but his own, but after meeting a few English people, conceived a great desire to visit that country. He became somewhat sympathetic with the Turkey movement and fell somewhat under the Sultan's suspicions, went to England where he remained. The author loves his country but detests the present Sultan and sheds a somewhat lurid light upon his reactionary methods.

Macedonian Folklore, by G F. ABBOTT. University Press, Cambridge, 1903. pp. 372.

The writer under the Prendergast studentship went to the Greek speaking parts of Macedonia and derived his material almost entirely from oral tradition, occasionally supplementing it by local publications and peasant almanacs. He groups his material under folk calendar and seasons, Eastertide, winter festivals, divination, symbolism, birth, marriage, funeral rites, spirits and spells, bird legends, riddles, Alexander and Philip in folk tradition. He has, we think, happily refrained essentially from speculation or to making spiritual excursions into the unknown, although Tyler, Lang, and especially Frazer, to whom the work is dedicated, are his ideals. Some of his matter, especially the songs and poems, are given in Modern Greek.

Great Benin: Its Customs, Art and Horrors, by H. LING ROTH. F. King and Sons, Halifax, 1903. pp. 234 + xxxii.

The writer has made a protracted, personal study of the people of this interesting province and here describes with the aid of two hundred and seventy-five pictures their appearance, customs at birth, marriage and burial, their wars and weapons, trades and industries, foods, animals, medicine, music, games, court life, slavery, inheritance, government, punishments, ordeals, fetiches, kindred observances, etc.

The Land of the Dons, by LEONARD WILLIAMS. Cassell and Co., London, 1902. pp. 398.

The author was long a correspondent of the Times, in Madrid, and has explored many parts of Spain and both loves and understands it. We have nowhere seen so full an account as it exists to-day and as it has been transformed in recent centuries. The author gives a very good account of the people, the customs, industries, and even appends a sketch of Spanish history. He declares that it was generally felt to be an advantage for the Spaniards to lose their provinces, but he can see only a gloomy prospect unless the following reforms are affected: popular education, the suppression of the national lottery, retrenchment of the army and navy, reduction of the pension lists, the sup-

pression of taxation upon food stuffs and the various monopolies, a non-political service, and some settlement of the religious question.

To-day in Syria and Palestine, by WILLIAM E. CURTIS. F. H. Revell Co., Chicago, 1903. pp. 528.

This is an effort to describe the Holy Land and the historical scenes in Syria as they appear to-day to a newspaper reporter. The writer confesses that his trip destroyed many illusions, weakened his confidence in professional teachers of Christianity, confirmed his faith in the Bible and for every spot that could be identified.

Methods and Aims in Archæology, by W. M. FLINDERS PETRIE. Macmillan and Co., London, 1904. pp. 208.

No one, surely, is more competent to treat this theme than the author, and his chapters on the excavators, on discrimination, the laborers, arrangement of work, recording in the field, copying, photographing, preservation of objects, packing, publication, systematic archæology, archæological evidence, ethics of archæology, altogether constitute very interesting reading.

Das Asylrecht der Naturvölker, von A. HELLWIG. R. V. Decker, Berlin, 1903. pp. 122.

This is a valuable contribution by a pupil of Professor Kohler, Berlin, who attempts to gather from all the known races of Australia and the Southern Sea in Africa, all the instances of the rite of asylum whether in time or in place. This involved a study of the rites of hospitality to strangers of all places and conditions where criminals or others might be sure of safety and protection. From his preliminary studies he thinks these rites less among the North American Indians than among other savage people. He has given us an important contribution to primitive ethics and to the anthropology of jurisprudence.

Nervous and Mental Diseases, by ARCHIBALD CHURCH and F. PETERSON. 4th ed., revised. W. B. Saunders, Philadelphia, 1903. pp. 922.

We welcome this thoroughly revised fourth edition, a work throughout abounding in interest to psychologists. The latter, however, will perhaps be especially interested in the nearly forty pages entitled, "A Review of Recent Problems of Psychiatry," by Adolf Meyer, lately docent in Clark University and now director of the Pathological Institute of the New York State Hospital. This exceedingly interesting and valuable survey is largely devoted to the work of Kræpelin, Zihen and Wernicke.

Lehrbuch der Speziellen Psychiatrie für studierende und ärzte, von ALEXANDER PILCZ. Franz Deuticke, Leipzig, 1904. pp. 249.

In the first section the author treats of acute functional insanity under which he includes mania and amentia. Then comes functional, chronic insanity including paranoea, periodic and alcoholic insanity and dementing processes. About twelve pages are given to dementia præcox and a few to thyrogenic insanity. Then follows insanity of the great neuroses, innate defects, partial responsibility.

The Journal of Infectious Diseases. Ed. by Ludvig Hektoen & Edwin O. Jordan. Chicago, 1904. pp. 210.

This is, we believe, the fifth new American publication devoted mainly to the publication of results of research in the field of medicine. The others are the Journal of Experimental Medicine, the American Journal of Physiology, the American Journal of Medical

Research, and the American Journal of Anatomy. These five journals and their content, which are a credit to the medical profession, were made possible by the development of what Professor Barker calls the semi-university schools of medicine where in six or eight of the best centres the first two years' study is devoted to the applications of these sciences to disease, hospital visitation, clinical practice, etc. Most of the work published in these five journals would have been impossible so long as medical professors were also practicing physicians. That so many of those who in the last two years are still so is a just ground of reproach, and until this evil is removed we shall not have real medical schools in the best European sense.

Hirnanatomie und Psychologie, von L. EDINGER. August Hirschwald, Berlin, 1900 pp. 25.

This book is an interesting summary of the present status and recent changes in the study of the brain.

The Neurones and the Neurone Concept considered from the Anatomical, Physiological, Pathological and Psychological Point of View, by WESLEY MILLS. Montreal Medical Journal, December, 1903. pp. 22.

This is a convenient latest attempt to sum up in popular form, with the use of thirty diagrams, the present views concerning neurones. Convenient as it is, it has what we deem the great defect of making no attempt to give the literature upon the subject.

Die Erregung, Hemmung, und Narkose, von N. E. WEDENSKY. Martin Hager, Bonn, 1904. pp. 152.

For a score of years this vigorous thinker has devoted himself largely to the problem which Setchinoff first made prominent, namely inhibition, and here he sums up in a concise way his own conclusions having brought it into formal relation with excitation and narcosis. He has reached the conclusion that narcotic states can be caused by ordinary means of excitation and that these are in turn akin to inhibition. This interesting work needs fuller notice which we hope to be able to give later.

Krystallisation und Morphogenesis, von MORIZ BENEDIKT. Moritz Benedikt, Wien, 1904. pp. 68.

This is chiefly an account of the as yet mostly unpublished researches of the Roman savant Schroen which Benedikt thinks show a connecting link between animate and inanimate nature. Development of energy by slight stimuli is not a specially psychic phenomenon. There is no specific protoplasm. Mineral organization is not entirely different from that of life. Benedikt concludes with a wild speculation about the possibility of living creatures in the sun.

Response in the Living and Non-Living, by JAGADIS CHUNDER BOSE. Longmans, Green & Co., London, 1902. pp. 199.

The author treats here of the mechanical response of living substances to different stimuli, electric response in general, electric response in plants and the method of negative variation, the block method, effects of single stimulus and of superposed stimuli, diphasic variation, the relation between stimulus and response, the influence of temperature, anæsthetics and poisons. The response in metals is then considered together with inorganic response and that in metals generally. The methods of ensuring consistent results, molecular mobility, fatigue, and modified response in inorganic material, the effects of chemical reagents, reactions to light, retinal currents, and

visual analogues, conclude the topics treated. Most of these papers are transformed and edited from the earlier publications of the writer.

The Special Physics of Segmentation as shown by Synthesis, from the standpoint of universally valid dynamic principles, of all the artificial parthenogenetic methods, by E. G. SPAULDING. Reprinted from the *Biological Bulletin*, Vol. VI, No. 3, February, 1904. pp. 97-122.

Einführung in die Experimentelle Entwickelungsgeschichte, von OTTO MAAS. J. F. Bergmann, Wiesbaden, 1903. pp. 203.

Every student of these subjects will heartily welcome an attempt to bring together in order all the various efforts to control development of the early stages of life by the application of chemical, physical, thermal and other methods. The larger part of the work is devoted to the specific, internal factors of development, and the book is copiously illustrated.

Über die Bedeutung des Darwin'schen Selectionsprincips, von DR. LUDWIG PLATE. 2d ed. W. Englemann, Leipzig, 1903. pp. 247.

The writer first discusses objections to Darwinism that he believes unessential or passé. He then passes, after this introduction, to the essential and genuine objections which he finds to be very many, and finally attempts to sum up the factors of development as they must be apportioned between Darwin, Lamarck, Weismann, Roux, Wallace and others.

The Prevailing Conception of Degeneracy and Degenerate, with a plea for introducing the supplementary terms, deviation and deviate, by G. L. WALTON. Boston Medical and Surgical Journal, Vol. CL, No. 3, pp. 61-63. Jan. 21, 1904.

Walton objects even to the term superior degenerate because it has been associated with rather extreme types of decadence. Many stigmata which he would include under the term deviate, like, for instance, flecks on the iris, different shade of the two eyes, are too slight to be called degenerate.

While there is much to be said in favor of the word deviate neither it nor perhaps any other that can be suggested is sufficient to designate the very many forms of human aberration. For instance, precocity and retardation do not involve deviation from the line of normal development but only acceleration or slowness of progress on it. This the term deviate does not exactly express. Neither does aberrate or variate which has also been suggested. Perhaps abnormal is abstractly the best word, but this, too, has now unpleasant associations as any of the new words would soon have if generally adopted.

Symbol-Psychology; A new interpretation of Race-Traditions. By ADOLPH ROEDER. Harper & Bros., New York, 1903. pp. 204.

This, if we understand it aright, is a very unique book. It selects seven themes from folk-lore and presents a composite or comparative account of the main features of each, and then makes very bold suggestions as to what in the soul or in the history of nature or man in the past they symbolize. The seven themes he selects are the following: the twin-brother story; the man-animal story; the life-token; journeys and wanderings; the captive maiden; gods, heroes, dwarfs, and giants; the architecture of souls. The first question that naturally arises is, "Has the author really found typical story roots from the very many that might be selected, and especially, has he really found his way to the common centre or root?" This being granted, the far greater question of the soundness of his very bold suggestions as to interpretation may well give us pause.

Allgemeine Psychologie, von PAUL NATORP. N. G. Elwert, Marburg, 1904. pp. 63.

This professor of philosophy has favored us with an epitome of his own course of lectures designed, perhaps, primarily for his own students. He begins after the manner of his school with consciousness and the ego and its object, the division of phenomena into physical and psychic, and then discusses a few physiological conceptions like the nervous system, sense organs, etc., passes thence to the concepts, first time and space, after which he discusses association, apperception, attention, and finally ideas. He is in general true to the Herbartian compositions colored, however, by Lotze and Kant.

The Direction of Hair in Animals and Man, by WALTER KIDD. A. & C. Black, London, 1903. pp. 154.

The author seeks to co-ordinate the scattered facts of the direction of hair in the lower animals and man, to interpret most of them upon mechanical principles, and also to supply an answer to the question whether acquired characters can be inherited. He shows in general that the hair streams grow along lines of least resistance, gravity being a rather dominant factor. The author believes that he has demonstrated the fallacy of Weismannism by his studies. Next to gravity underlying and divergent muscular traction and pressure and lines of least resistance are the author's principles of explanation. That the author has explained his facts adequately no one, perhaps not himself, would claim, and it is we think, no less evident that he has been diverted into criticisms of Weismann which mar the unity of his work.

Das Leben im Weltall, von LUDWIG ZEHNDER. J. C. B. Mohr, Tübingen, 1904. pp. 125.

This Professor of Physics in the University of München discusses atomism in general and its relations to ether, heat, sound and light. The second part is devoted to the building up of bodies, aggregate states, molecules, assimilation, fistella and adaptation. The author then treats the methods of life beginning with the simplest, including differentiation, plants and animals, psychic life, races and states. Lastly, the structure of the world, planet systems, comets and eternal circulation, somewhat in the sense of Plato's aeon theory, is discussed.

Die Gesichtspunkte und die Tatsachen der psychophysischen Methodik, von G. E. MUELLER. J. F. Bergmann, Wiesbaden, 1904. pp. 244.

We have here a masterly and perhaps almost epoch-making work, which is also most timely. We regret that our limitations prevent us from giving a more extended account. We can only name a few of the general topics treated to show the scope of the work. Judgments of various forms in experimental processes are first considered, and the necessity of absolute conscientiousness as well as of subjective and objective confirmation. The danger of half scientific processes is well stated. The choice of D's (= differences) and their series is dwelt upon. In the next chapter the determinations of thresholds and their variability are treated with various formulæ and their use, together with elimination of errors, fractioning, absolute and differential thresholds. The relation between S and h is given considerable attention. Next comes the element of absolute impression and all that it implies in the field of the various senses, especially in time; then the modes of treating the judgment numbers, the studies of distraction, average error, limitation, equivalent stimuli, differentiation, etc.

Die Nachahmung und ihre Bedeutung für Psychologie und Völkerkunde, von P. BECK. Hermann Haacke, Leipzig, 1904. pp. 173.

A serious treatise with no index, not even that of chapters, with no italics, no summaries, is, we believe, unless it has peculiar merit, destined to obscurity. There is no way to get into a book like this. To be sure some sections are headed perception, language, imitation, reason, kultus, morality, science. We believe that a book which must be read through before it can be understood what field it covers is doomed to oblivion. We have not time to give a hard day or two's work to find out whether this book is very good or very bad. It seems to be more philosophical than scientific.

La Vision, par J. P. NUEL. (Bibliothèque internationale de psychologie expérimentale, normale et pathologique.) Octave Doin, Paris, 1904. pp. 376.

The writer attempts to summarize the researches of the last few years in this field. The first part discusses vision in animals. The second part, beginning with page 115, treats visions in man. The work does not pretend to be a pioneer work, but is a good summary of the field included, with a bibliography brought up to date. It is well provided with indexes.

Die stammesgeschichtliche Entstehung des Bienenstaates sowie Beiträge zur Lebensweise der solitaren u. sozialen Bienen (Hummeln, Meliponinen, etc.), von H. VON BUTTEL-REEPEN. G. Thieme, Leipzig, 1903. pp. 138.

This distinguished author has here expanded a lecture, originally given in 1902, into a little volume in which he describes the methods of animal psychology, the conceptions of instinct, reiterates his views that bees and wasps are not automata. The natural history of the bee the author traces back to several forms of insect ancestry which burrowed and laid their eggs in single holes in the ground. Sometimes these insects were solitary. Later their burrows were somewhat grouped together either in vertical, spiral or other forms. Burrows with two or three branches, nests like those of many ants honeycombed with passages, mud wasps that dig a group of holes together, bumble bees and their well known nests—all these are stages toward the development of the hive and honeycomb. In the second part, entitled Physiology without Biology, the author returns to his controversy with Bethe, and in the end collects a valuable literature of one hundred and ninety-nine titles.

Die Elemente der Musikalischen Æsthetik, von HUGO RIEMANN. W. Spemann, Berlin, 1900. pp. 237.

This work, by a Leipzig docent who is an expert in music, discusses art and music in general, then takes up pitch, timbre, dynamics, the roots of art, scale and harmony, dissonance, tonality, rhythm, motive, imitation, contrast and tone painting.

Grundzüge der allgemeinen Ästhetik, von STEPHAN WITASEK. Johann A. Barth, Leipzig, 1904. pp. 410.

This book is the unified product of many contributions of its writer to this subject. He first discusses the problem and methods of æsthetics, its material point of view, and then surveys æsthetic facts, objects, chief types, the state of the subject, the nature of æsthetic enjoyment, pseudo æsthetic factors of enjoyment, the explanation of them, the æsthetic norm, etc., and from this standpoint undertakes to define and describe true art.

Der Ursprung der Kunst. Von YRJÖ HIRN. Johann Ambrosius Barth, Leipzig, 1904. pp. 338.

This is a translation from English into German of this remarkable and well known work by this author.

Versuch einer Stellungnahme zu den Hauptfragen der Kunstphilosophie, I, von K. S. LAURILLA. Helsingfors, 1903. pp. 251.

We have here a very philosophical discussion of art, its idea, its essence and nature, its origins, problem, significance for modern life, and lastly its relations to morality. The writer is evidently a good man and a religious one and few would dispute the general drift of his argument but it may well be doubted whether much of value is added to the subject by so abstract a discussion of it.

Balance, the Fundamental Verity, by ORLANDO J. SMITH. Houghton, Mifflin & Co., Boston, 1904. pp. 146.

This is an honest, well-meant book intended to show the triumph of righting justice in the world, especially that the soul is accountable, that it survives death, and that there is a supreme power that rights things.

The Neighbor, by N. S. SHALER. The Natural History of Human Contacts. Houghton, Mifflin & Co., Boston, 1904. pp. 342.

This, like the two preceding books of the same author, was worth writing and will prove for some worth reading. Like the others it will be also disappointing to those who expect much scholarship in the fields it touches or much novelty in the way of suggestions. It is a strong instinct and no doubt an excellent practice for scientists who have devoted long and laborious years to their department to expatiate on larger general questions. They are generally hard-headed, practical, sensible men and the muse of common sense will always have its votaries. We confess to a little disappointment in reading the writer's treatment of the Hebrew and the African problem. The former is largely historical and it would seem as though his long academic experience and observation might have taught him more of living present interest. That he really adds to our knowledge of the African cannot be said.

L'Individualisme Anarchiste. Max Stirner. Par VICTOR BASCH. Félix Alcan, Paris, 1904. pp. 294.

Max Stirner was born in 1806 and died in 1856. He was in youth a pupil of Hegel and after taking his degree became teacher in a girls' high school in Berlin. Here, in 1844, he wrote his remarkable book entitled "Das Ich und sein Eigenthum." In this he carried the affirmation of individualism and even selfishness to its utmost extreme as against Hegelism which subordinates persons to movements of the Zeit Geist. This book produced considerable sensation, but its advocacy of extreme and selfish egoism unsettled the author. He had to resign his position and thenceforth lived in squalor doing hack work. His second wife, also an extreme socialist and from whom he was divorced and who lived on till 1896 in London, is said to have sunk very low. Stirner would have been almost forgotten had it not been for the interest in Nietzsche of whom he is called one of the precursors. This prompted John Henry MacKay to write Stirner's life and it also prompted this book.

Die Familie, von W. H. RIEHL. 12th ed. T. G. Cotta, Berlin, 1904. pp. 321.

This prolific author here publishes the twelfth edition of his work.

It is divided into two parts, the first treating man and woman, and the second, home and family.

Ethik als Kulturphilosophie, von PAUL BERGMANN. Theodor Hofmann, Leipzig, 1904. pp. 639.

This book treats first of the development of the moral consciousness in the history and deeds of mankind, while the second part is devoted to ethics as a culture philosophy. The author claims that moral consciousness is unique and that his way of treating the problem, sources, and method makes ethics scientific. Considerable space is given to the matriarchie and to patriarchal systems, and one long chapter gives a good account of the history of the philosophy of ethics from Greece down. One of the bases of morals is sociopsychological.

The Neo-Platonists: A study in the history of Hellenism, by THOMAS WHITTAKER. University Press, Cambridge, 1901. pp. 231.

This volume appears to be an admirable study from first hand sources of the system of Plotinus, and those most closely related to him. Sections each are given to Porphyry, Iamblichus, and Proclus. The author rates the historic importance of Neo-Platonism very high.

La Philosophie en Amérique depuis les origines jusqu'a nos jours (1607-1900), par L. VAN BECELAERE. Electric Publishing Co., New York, 1904. pp. 180.

We have here, at last, an attempt to write a comprehensive history of philosophy in America for three centuries down to the present. It is a bold and somewhat ambitious attempt but one that must be called singularly successful. Quite a number of triolet surveys from various standpoints and covering limited periods have been attempted within the last score of years. These the author utilizes to the full and has presented, on the whole, an admirable survey. He first discusses the American spirit in its relations to speculative thought, then treats the colonial period, the Scotch and German influence, contemporary schools, idealists, the philosophy of evolution, psychology, with a final chapter on the present hour. It is dedicated to the Honorable William T. Harris, and introduced by a nine-page article by Professor Royce. It is, of course, easy for those who have followed the course of events in this field for a score of years to find defects and omissions and, of course, no one could entirely agree with any one else's verdict either implied or expressed about any contemporary matters or persons. The form of the book is not attractive and its serviceableness is seriously handicapped by the lack of an index. Neither can we understand why the author, writing on American philosophy, has not put his historic essay in English into which language it certainly ought to be speedily rendered. He has, however, placed every one interested in these subjects under special obligation and it cannot fail to set things in a wider perspective and give us all broader and more historic views of our own work. It is singular that it should be left for a new comer in this country to do this work, but no less singular that it has been done so well.

Das Idealistische Argument in der Kritik des Materialismus, von M. WARTENBERG. Johann A. Barth, Leipzig, 1904. pp. 72.

The author attempts to prove that epistemological idealism can decide nothing as to the justification of materialism, that is, that it can never refute this, but he attempts a vigorous criticism of materialism on other grounds. To successfully refute it one must neither begin with nor lay much stress upon epistemology.

Sulla Filosofia Monistica in Italia. Introduzione del Prof. Enrico Morselli. Unione Tipografico-Editrice, Torino, 1904. pp. xliii.

The monistic philosophy has had an extraordinary career not only in the last two or three decades, but ever since Bruno, in Italy. This career to owes, no doubt, essentially to reaction from the Catholic church. This convenient introduction with its voluminous literature is a good open sesame to the study of this development.

Die Metaphysik Benekes, von ALBRECHT WANDSCHNEIDER. Ernst Siegfried Mittler und Sohn, Berlin, 1903. pp. 155.

It is a very useful service which this adept has rendered students of philosophy in summing up the never entirely harmonized and co-ordinated metaphysical views of Beneke. This he does conveniently with the captions, problem and method of metaphysics, origin of concepts, their relations to being, the forms of the latter, and religious philosophy. In the final chapter the author expresses his own profound appreciation of the unique metaphysical views of Beneke.

The Categories, by JAMES HUTCHINSON STIRLING. Oliver & Boyd, Edinburgh, 1903. pp. 158.

In this little book the author breaks a philosophy science of years and indicates the lines of his own active thought since the publication of his famous "Secret of Hegel" nearly a quarter of a century ago. That his devotion to Hegel has not waned is plain from the second chapter. The chapter entitled "Religion and the Categories" is perhaps, on the whole, the most suggestive. It is an interesting book, but we still profoundly need an historical treatise on this subject.

Descartes, Spinoza and the New Philosophy, by JAMES IVERACH. T. & T. Clark, Edinburgh, 1904. pp. 245.

This work gives a very good picture of Descartes and Spinoza. It first discusses the Middle Ages and its problems and then describes how Descartes grew discontented with the knowledge of his age. He criticises the *cogito, ergo sum* and also the arguments for the existence of God. Spinoza is treated in a somewhat similar way, and the two philosophers are compared.

Deutsche und aufserdeutsche Philosophie der letzten Jahrzehnte dargestellt und beurteilt, von DR. J. BAUMANN. F. A. Perthes, Gotha, 1903. pp. 533.

The writer attempts to give us a brief sketch of the views of many leading thinkers of the last ten years. Those to whom the most space is given are Hartmann, Wundt, Eucken, Mock, Nietzsche, Rickert, Ostwald, who has most space of all, Riehl, Spencer, Green, Bradley, Taine, Ribot, Renouvier, Foullier, but many others are treated including James.

Moderne Philosophen, von M. KRONENBERG. C. H. Beck, München, 1899. pp. 221.

These five essays, with the exception of that on Ludwig Feuerbach, have appeared previously. One chapter each is given to Hermann Lotze, Fr. Alb. Lange, Victor Cousin, Ludwig Feuerbach, and Max Stirner.

Zur Einführung in die Philosophie der Gegenwart, von ALOIS RIEHL. B. G. Teubner, Leipzig, 1903. pp. 258.

The topics here treated are the essence and development of philosophy in antiquity, modern philosophy and its relations to exact science, critical philosophy, the bases of knowledge, natural science and philosophical monism, the problem of *Lebensanschauung*, Schopenhauer and Nietzsche, the present and future of philosophy.

Geistige Strömungen der Gegenwart, von RUDOLF EUCKEN. Veit & Comp. Leipzig, 1902. pp. 398.

This fecund philosopher here greatly amplifies an earlier publication of his which is here presented as the third edition. In it he tells what is the fundamental idea of mental life subjectively, objectively, theoretically, practically, etc. He discusses idealism, realism, problems of knowledge, of the world, of human life, history, society, art, morals, personality, character, freedom of the will, and finally religion. His fundamental idea of the higher spiritual world demonstrated by immediate intuition pervades this as all his other writings.

The Pathway to Reality, by RICHARD BURDON HALDANE. John Murray, London, 1904. pp. 275.

All who are not experts will thank the author for giving us in eleven pages an epitome of these lectures to which he appends a survey of the ground covered in the twenty Gifford Lectures now given. The first book in this volume is devoted to absolute mind, and the second to finite mind.

Geschlecht und Kinderliebe, von DR. P. J. MÖBIUS. Carl Marhold, Halle, 1904. pp. 72.

This pamphlet sets forth the difference in the feelings of the two sexes toward children, and contains thirty-seven cuts of skulls of birds and animals illustrating sex differences. Much space is given to discussing the doctrines of Gall.

Science de l'Homme et Méthode Anthropologique, par ALPHONSE CELS. Felix Alcan, Paris, 1904. pp. 453.

In this hand book we have an exceedingly comprehensive if not very intensive or detailed account of Anthropology, its methods, its matter. It includes the organization of human nature, the unity of our race, life and vital force in man, mesology, the laws of the body, of the soul and the spirit, the relations of men and women, family, etc. So general a work cannot entirely escape the charge of being superficial.

Twentieth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. 1898-1899. By J. W. POWELL. Government Printing Office, Washington, 1903. pp. 237.

Besides the Director's report of 224 pages, attempting to cover the entire world of learning and which is certainly very curious in some of its sections, the chief content of the volume is a very copiously illustrated article of 237 pages on aboriginal pottery of eastern United States by W. H. Holmes. As in so many of the reports of this bureau the cuts occupy more space than the text itself.

Betrachtungen ueber das Wesen der Lebenserscheinungen, von PROF. R. NEUMEISTER, 1903. pp. 107.

The author argues that despite all the assertions (and in the nature of the case they can be nothing more) of the mechanists there remains a transcendent problem. Physiology has done nothing hitherto to explain the real nature of vital processes. Many relations and sequences have been established but not one of even the simplest problems of life have been elucidated. Justly discredited as was the old vitalism something like another purposive agency must be assumed.

Studies in Voluntary Muscular Contraction, by THOMAS ANDREW STOREY. University Press, Stanford University, California, 1904. pp. 62.

This is a very careful study of years of evidence derived from both

individual and group studies all of which point harmoniously to an increasing period of morning ability until ten or eleven or later and then fall, with an afternoon rise until three or four and fall at six, with an early evening rise and fall at nine or ten. Thus this would seem a normal variation in the power of muscles to do work and it is about the same whether the power is called forth by electrical or by voluntary stimulus.

The Journal of Philosophy, Psychology and Scientific Methods. Vol. I, No. 4, February 18, 1904. The Science Press, Lancaster, Pa. pp. 85-112.

We welcome and bid hearty godspeed to the new Journal of Philosophy, Psychology and Scientific Methods, edited by Professor J. E. Woodbridge of Columbia. It is a valuable addition to the arsenal of resources for all who teach these subjects. We sincerely wish, however, that the notes and book reviews might be fuller and more numerous.

A Method for the Identification of Pure Organic Compounds, by SAMUEL PARSONS MULLIKEN. John Wiley & Sons, New York, 1904. Vol. I, pp. 264.

This first volume contains classified descriptions of about twenty-three thousand of the more important compounds of carbon with hydrogen and with hydrogen and oxygen. The book is certainly admirably gotten up and is very impressively technical, consisting very largely of tables.

Die Grenzen der Geschichte, von F. GOTTL. Leipzig, 1904. pp. 142.

History and thought are "protuberances of a deeper content of ideas." History interprets being to get at what has happened. Historical geology interprets what has happened in order to get at being. All else is metahistorical. History must be emancipated from natural history.

Man's Place in the Cosmos and other essays, by A. SETH PRINGLE-PATTISON. Wm. Blackwood & Sons, Edinburgh, 1902. pp. 319.

These are various essays, the first giving the title to the book. The others discuss the present position of the philosophical sciences, the new psychology and automatism, a new theory of the absolute, Balfour, Nietzsche, the venture of theism.

The University of Colorado Studies. Vol. I, No. 4. Univ. of Colo., Boulder, Colo., February, 1904.

This series of studies, established by the late Arthur Allin, contains what is probably his last paper. It is on laughter, and gathers up the data collected and the work done since the paper of Hall and Allin six years ago.

Grundzüge der Physiologischen Psychologie, von WILHELM WUNDT. Wilhelm Engelmann, Leipzig, 1903. pp. 133.

W. Wirth, a private docent and assistant in Wundt's laboratory, has here given us an elaborate topical and personal index to Wundt's last three-volume edition of his psychology.

Proceedings of the Society for Psychical Research. Part XLVII, Vol. XVIII, January, 1904. R. Brimley Johnson, London, 1904. pp. 103-322.

The chief article is on the phenomena of Mrs. Thompson's trances, with a brief article on certain unusual psychical phenomena, by John Honeyman.

An Establishment of Association in Hermit Crabs (Eupagurus Longicarpus), by E. G. SPAULDING. Reprinted from the *Journal of Comparative Neurology and Psychology*, Vol. XIV, No. 1, Larch, 1904. pp. 49-61.

Theorie der Beobachtungsfehler, by EMANUEL CZUBER. B. G. Teubner, Leipzig, 1891. pp. 418.

Recherches Algésimétriques, par J. IOTEKYO et M. STEFANOWSKA. (Laboratoire psychologique Kasimir, Université de Bruxelles.) Bruxelles, 1903. pp. 86.

Rapport Quinquennal (1898-1903) *sur les travaux du Laboratoire Psychologique Kasimir*, par MLLE, J. IOTEYKO. Hayez, Bruxelles, 1903. pp. 20.

The Journal of Logic. Vol. 1, No. 1, June, 1904. S. S. Hebberd, Chesterfield, Ill. pp. 39.

Problems in Astrophysics, by AGNES M. CLERKE. Adam & Charles Black, London, 1903. pp. 567.

A History of Dancing from the Earliest Ages to Our Own Times, from the French of Gasto Vuillier, with a Sketch of Dancing in England, by JOSEPH GREGO. D. Appleton and Co., New York, 1898. pp. 446.

A Study in Reaction Time and Movement, by THOMAS V. MOORE. *Psy. Rev.* Monograph Supplement, Vol. 6, No. 1, April, 1904. pp. 86.

The Rhythm of Immunity and Susceptibility of Fertilized Sea-Urchin Eggs to Ether, to HCl, and to Some Salts, by E. G. SPAULDING. Reprinted from the *Biological Bulletin*, Vol. VI, No. 5, April, 1904. pp. 224-240.

Die Abstammung des Menschen und die Bedingungen seiner Entwicklung, von MORITZ ALSBERG. Th. G. Fisher & Co., Cassel, 1902. pp. 248.

Recherches expérimentales sur l'Hérédité chez les Vers à Soie, par GEORGES COUTAGNE. L. Danel, Lille, 1902. pp. 194.

Evolution of the Japanese, by SIDNEY L. GULICK. Fleming H. Revell Co., New York, 1903. pp. 457.

Leitfaden der Psychologie, von THEODOR LIPPS. Wilhelm Engelmann. Leipzig, 1903. pp. 349.

Les Actions naturelles possibles sont inaptes à produire des effects semblables à la retouche intentionnelle, par M. A. RUTOT. Hayez, Bruxelles, 1902. pp. 68.

The Psychological Bulletin. Literary section of the Psychological Review. Special Association Number. Vol. I, No. 2, February 10, 1904. The Macmillan Co., New York. pp. 56.

Wokas, A Primitive Food of the Klamath Indians, by FREDERICK VERNON COVILLE. Report of the United States National Museum for 1902. pp. 725-739. Government Printing Office, Washington, D. C.

De la Mémoire, par J. LARGUIER DES BANCELS. Archives de Psychologie, Tome III, No. 10, février, 1904. H. Kündig, Genève, 1904. pp. 145-163.

Jahresbericht über die Fortschritte der Physiologie, von L. HERMANN. Emil Strauss, Stuttgart, 1903. pp. 341.

NOTES.

British Medical Association.

The seventy-second annual meeting of the British Medical Association is to be held at Oxford, July 26-29. In connection with Section E, Psychological Medicine, the following discussions have been arranged:

July 27. Criminal Responsibility and Degeneracy, introduced by Dr. Chas. A. Mercier. Dr. Max Nordau will take part in the discussion.

July 28. Heredity, introduced by Medizinalrat Dr. W. Koenig, of Dalldorf Asylum, Berlin (psychiatrical aspect), and Dr. J. Beard (biological aspect).

July 29. Dementia præcox, introduced by Dr. C. Norman.

Congress of Philosophy.

The second international Congress of Philosophy will be held at Geneva, September 4-8, 1904. The Congress will meet in five sections: History of Philosophy, General Philosophy and Psychology, Applied Philosophy (ethics, æsthetics, social philosophy, philosophy of religion, philosophy of law), Logic and the Philosophy of the Sciences, History of Science. The card of membership costs 20 francs; the official languages of the Congress are English, French, German and Italian. All communications should be addressed to M. le Dr. E. Claparède, 11 Champel, Geneva, Switzerland.

St. Louis Congress of Arts and Science.

The revised programme (June 20, 1904) of the International Congress of Arts and Science, to be held at the Universal Exposition, St. Louis, Sept. 19-25, contains the following:

DIVISION OF MENTAL SCIENCE.

Speaker. President G. Stanley Hall, Clark University, Worcester, Mass.

DEPARTMENT OF PSYCHOLOGY.

Chairman. Professor Noah K. Davis, University of Virginia.
Speakers. Professor J. Mark Baldwin, Johns Hopkins University, Professor J. McK. Cattell, Columbia University.

SECTION A. GENERAL PSYCHOLOGY.

Chairman. Professor Chas. A. Strong, Columbia University.
Speakers. Professor Harald Hœffding, University of Copenhagen, Professor James Ward, University of Cambridge.

SECTION B. EXPERIMENTAL PSYCHOLOGY.

Chairman. Professor Edward A. Pace, Catholic University of America.

Speakers. Professor Hermann Ebbinghaus, University of Breslau, Professor E. Bradford Titchener, Cornell University.

SECTION C. COMPARATIVE AND GENETIC PSYCHOLOGY.

Chairman. Professor Edmund C. Sanford, Clark University.
Speakers. Principal C. Lloyd Morgan, University College, Bristol, Professor Mary Whiton Calkins, Wellesley College.

SECTION D. ABNORMAL PSYCHOLOGY.

Chairman. Professor M. Allen Starr, Columbia University.
Speakers. Dr. Pierre Janet, Sorbonne, Paris, Dr. Morton Prince, Boston, Mass.

GERMAN CONGRESS OF EXPERIMENTAL PSYCHOLOGY.

A Congress of Experimental Psychology, was held at Giessen, April 18-21, under the presidency of Professor G. E. Mueller of Gœttingen. The Congress resulted in the formation of a Society for Experimental Psychology, which has decided to hold a second meeting at Wuerzburg in the Easter vacation of 1906. Intending members should communicate with the Secretary of the Society, Dr. F. Schumann, Berlin N. W., Dorotheenstrasse 95/96 III; the yearly subscription is Mk. 5. Professor Sommer, of Giessen, has published (Leipzig, A. Barth) a pamphlet entitled Die Ausstellung von experimentall-psychologischen Apparaten und Methoden bei dem Kongress für experimentelle Psychologie, which contains useful information and a large number of figures (pp. 78, price Mk. 2.40).

THE AMERICAN
JOURNAL OF PSYCHOLOGY

Founded by G. Stanley Hall in 1887.

Vol. XV. OCTOBER, 1904. No. 4.

THE PSYCHOLOGY OF DAY DREAMS.

By Theodate L. Smith.

Perhaps not the least difficult question in connection with the present topic is what mental states shall be included under the term day dreaming. The usual definition "as an idle exercise of the imagination during waking hours," by no means covers the material of the returns, which include nearly every form of mental reproduction from the hypnagogic state, with complete absence of voluntary control, through varying phases in which the initial idea or general trend of the images is voluntarily determined, up to a distinctly purposive picturing of the future with due attention to probable realization. There are, however, certain characteristics which are common to this entire series of phenomena, namely a withdrawal of the attention, more or less complete, from the external senses, and a greater or less degree of mental automatism. Fechner[1] considers that in so far as attention is withdrawn from the senses, their condition is precisely the same as in real sleep and "*vice versa* the whole sphere of the activity of inner representations may fall asleep." According to this view, the mental life oscillates between sleeping and waking and there are regions of the brain asleep even in waking states and the distinction between dreams and day dreams is merely one of degree. For convenience in classification, day dreaming may be tentatively defined as including all those reproductive and imaginative mental states in which there is a greater or less degree of automatism in the images which come before the mind. Its limits would be, on the one hand, the hypnagogic states which immediately precede sleep and on the other, states of purposive

[1] G. T. Fechner: Elemente der Psychophysik. Leipzig, 1889, p. 440.

thinking in which the mind becomes so filled with the subject that its workings tend to become automatic. Some of those who answered the questions attempted definitions, a few specimens of which are here given.

F., 14. Day dreams are the thoughts and wishes which we imagine.
M., 15. Day dreams are dreams about things which are fancied and which have no real foundation.
F., 16. Day dreams are thoughts about what we want the most.
F., 16½. Day dreaming is simply the soul longing for something great.
F., 13. In day dreams, you first start out to think about one thing and then your mind wanders over many things which may or may not be connected with what you first start to think about. It is really going to sleep because you don't work with anything but your brain. You generally have day dreams when everything about you is quiet and you have nobody to talk to. You think, but you don't express your thoughts in words, its your brain that is holding a conversation.

The material for the present study was collected in response to a request contained in a syllabus on dreams.

"Ask all who can to write about their day dreams, what they are most often about, and describe one or more in detail; where and when they lapse to revery most often, and if they enjoy it or think it wrong, etc."

469 papers were received from normal school pupils, ages averaging from seventeen to twenty-five. 980 from pupils in the graded schools of ages ranging from seven to sixteen years. 23 from adults and three contributions were received from those who had passed the age of ninety, making a total of 1,475 cases. Of these 535 were from girls and 445 from boys in the graded schools. The normal school material was chiefly from girls, and of the adults slightly over one half were men. Among the entire 1,475 cases there were five (3 m. and 2 f.) who stated positively that they never had day dreams but of these five one, a man of twenty-five, described a mental state which would be included in the broader definition of day dreaming and two others were children who were classed in grades with children several years younger.

The physical characteristics of day dreaming most frequently mentioned were psychic deafness and blindness and muscular relaxation, including that of the eyes. Many children give descriptions of individual instances of this psychic deafness. They fail to hear bells or signals, say that their minds were far away, that the teacher had to speak several times to attract their attention, and one boy graphically describes an occasion on which his teacher threw a piece of chalk at him "to wake him up." A girl of twenty-one writes: "Sometimes I am so interested in my dreams that I do not see or hear anything that is going on around me." Another, of seventeen: "There are times when I

am so far away that I am entirely unconscious of my surroundings until there is some loud noise or my name is called." The "far away" look of the eyes is repeatedly mentioned and is an external sign of day dreaming which children readily recognize. A child of twelve gives her observations on the difference between hard thinking and day dreaming in these words: "When you do your arithmetic you pucker up your forehead, but when you are day dreaming your eyes look way off." This relaxation of the eye muscles which allows the axes to become parallel, or according to Donders, actually divergent, is similar to that in actual sleep. Le Conte proved experimentally that in drowsiness and drunkenness the double images are due to divergence of the optic axes and recognizes this as the absolutely involuntary and passive state of the eye in distinction from the involuntary tonic contraction of the healthy waking state which holds the lines of regard parallel, and the voluntary state of convergence.[1] It seems probable that both of the involuntary states are represented in day dreaming, actual divergence of the axes probably being confined to those mental states which most nearly approach the hypnagogic while the "far away" look so often mentioned is due to parallel axes. Besides these cases of more or less complete muscular relaxation there is another class in which day dreaming is an accompaniment of physical activity of a monotonous or automatic character, as walking, sewing, driving, swinging in a hammock, rocking, practicing piano exercises, hoeing, washing dishes, etc. In a few cases bodily automatisms which took the form of an unconscious acting out of the dream were reported, while in others they were quite unconnected with the images of the dream. Mr. Lindley, in his study of the phenomena of mental effort, reached the tentative conclusion that "many automatisms represent processes for the production and maintenance of central nervous energy as well as for the production of the state of attention, and this seems to hold good for states of attention where the object is internal as well as for sensorial states.[2]

The conditions mentioned as favoring day dreaming were twilight, moonlight, solitude, soft music, sound of the waves or falling water or any monotonous sound which tends to fatigue the attention, listening to an uninteresting lecture, sermon or recitation, physical or mental fatigue watching an open fire and looking at a distant landscape. It will be noted that several of these conditions are those favorable for inducing hypnosis. In a large percentage of the cases day dreaming is

---

[1] J. Le Conte: Sight, New York, 1881

[2] E. H. Lindley: Motor Phenomena of Mental Effort. *Am. Jour. of Psy.*, Vol. VII, July, 1896.

either directly associated with bodily or mental fatigue, or fatigue is suggested by the conditions mentioned. Many children name the later hours of the school session as the time for day dreaming and "bed time, before going to sleep" is a favorite hour for both children and adolescents. There are many indications that day dreaming is often the normal rest of the mind which takes refuge from monotony or fatigue of the attention by this method of relaxation. Voluntary attention is fatiguing even to adults and much more so to children whose control over the finer muscles is but partially developed. Binet[1] in his experiments on the effects of intellectual fatigue found that even for periods of work occupying less than fifteen minutes, there was relaxation of the eye muscles, and that for periods exceeding thirty minutes muscular effort, as tested by the ergograph, was diminished. Mosso[2] found that while in some instances the first effect of intellectual fatigue was to increase the energy of the muscles, it was followed by progressive enfeeblement.

Bound up with this question of fatigue is the relation of attention to day dreaming. Mosso considered in his experiments that attention was completely dispersed, when after an effort to make his mind a complete blank, images entirely uncontrolled by will trooped unbidden into his mind. But while this absolutely passive play of association is reported in a few cases, it is by no means the most typical form of day dreaming. From the teacher's point of view, the day dreaming pupil is certainly in a state of inattention, but in far the greater number of cases even voluntary attention is not wholly suspended, for the choice of subject is initially determined and if the subject of the dream becomes unpleasant it is usually changed or the dream is banished. Instead of complete dispersion of the attention, there is a withdrawal of it from the perception of outward things and a greater or less degree of concentration on the mental content. Usually this attention is of the passive sort but, even this is not always true, if in day dreaming are included those forms of story building which are worked out in logical sequence though possibly quite irrespective of their connection with facts. The tendency of day dreams to become more of the passive type is distinctly increased toward adolescence and danger of impairment of attention from over indulgence is clearly recognized. This is brought out in the opinions as to the rightness or wrongness of day dreaming which will be discussed later.

---

[1] A. Binet et V. Henri: La Fatigue Intellectuelle. Paris, 1898.

[2] Fatigue; A. Mosso, translated by M. and W. B. Drummond, London, 1904.

THE CONTENT OF DAY DREAMS AT DIFFERENT AGES.

In reading successively the papers furnished by the different school grades the change and increase in variety of content was very noticeable and there were a sufficient number of papers from the same grade in different localities to bring out differences fairly well. The dreams of the youngest children who could write (7 to 8 yrs.) were almost entirely of play and good times with a sprinkling of the fairy story type of dream. Memory images are very prominent and the chief imaginative alteration consists in making the dreamer's self the chief personage of the dream. The particular plays and ideas of a good time vary with the environment, as all classes of children from the rich to the extremely poor are included, but are reducible to a few fundamental interests, namely, plays which involve motor activities and out of door life, nature interests, especially in connection with animals, and eating. The plays and games of boys and girls show some divergence but out of door life and activity figure largely in both. Nature interests were especially noticeable in the returns from the Worcester schools and showed a greater variety than in returns from other localities. Images of good things to eat play quite a large part in the consciousness of both boys and girls, figuring in the fairy stories, picnics, excursions, birthday parties and Thanksgiving celebrations as well as by themselves. The eatables oftenest mentioned were candy, ice cream, cake and fruit of various kinds. In the returns from very poor children these dreams of eating were pitifully prominent and evidently affected by the physical conditions of ill nourished bodies, though the interest seems to be a perfectly normal one for children of all classes. The effect of insufficient nutrition on mental states is further brought out in some material[1] from Polish peasant children in which the questions "what is happiness" and "what is your greatest wish" were asked. "To have enough to eat," "never to be hungry," "to have enough bread," were the typical answers. For girls from eight to ten, the fairy tale form of day dream predominates over all others. It appears to be a mental device for compassing all desires, and actual experiences and possibilities are often mingled indiscriminately with the wildest impossibilities. Nearly all dream of being rich and having every desire gratified and the dream of being a princess and living in a palace "with a piano in every room" and having unlimited silk dresses and jewels may be mixed with the wish "to have enough good food every day." The *deus ex machina* in these dreams is most frequently a fairy godmother, though wishing caps, a magic

[1]Collected for the University by Madame Anna Goudzinska, of Kiev.

lamp or ring also figure. With boys of this age, the fairy story dream is less common and the form differs from that among girls. An interesting example of this occurred in a grade where the children were evidently all familiar with the story of Aladdin's lamp and the magic carpet. Nearly all of these had day dreams of flying or being transported through the air. Nearly all the girls had preserved the original forms of the stories with slight alterations, but the boys dreamed of all sorts of wonderful flying machines, sometimes mentioning the rate per hour, of trips in a balloon or by means of mechanical wings, of which they were in some cases the inventors. The desire for riches, while quite as wide-spread among boys as among girls, seems to demand a more logical explanation of its origin than that furnished by a fairy godmother. Dreams of finding money in amounts varying from fifty cents to five million dollars occur or the dream may be projected into the future and acquiring a fortune by possible or impossible means may be imagined, but however improbable the dream there is usually an attempt at logical consistency in it. Typical examples of these dreams are the following:

M., 9. Once I dreamed of finding a fifty-dollar gold piece. The first thing I bought was a bicycle and a riding suit for thirty dollars. And the other twenty dollars I gave to my mother.

F., 10. One of my day dreams was that I could live in a lovely castle. Eat good food, fruit, and vegetables. And be a fairy and have a wand. I could have a hundred houses full of $20. dollar bills. And ride in a lovely diamond flower team. Have as many dolls as I would wish. And have doll carriages dressed in silk. It would be summer all the time. I could have white silk dresses, pink, blue and bright gay colors I could have as many boys and girls to play with me. And I could have story books.

M., 9. Once I have thought that when I am a man I should like to be a millionaire and have a house with green grass as far as I could see. And a hundred horses, fine runners. And every day go out on some lake on a canoe and have a man to take care of a canoe better than anybody else. And the best horses in the world and all the things I could think of, I could have.

F., 10. I want to be a king's wife and live in a large castle. And have a great many rooms and in each a nice piano. And have a long silk robe of red, pink and many other colors. And have a Morris-rocking-chair with diamonds and rubies.

These childish dreams of wealth rarely show traces of the commercial instinct. It is always a means rather than an end, and children in whom the commercial instinct is strong are apt to have a much less imaginative type of day dream. They dream, but their mental images are much more closely related to facts. One boy of ten dreamed of playing marbles with another boy and that "he skun all his marbles." Good trades and means of actually earning money also figure in this type of day dreaming where images are usually furnished by the

immediate environment and undergo little change. Dreams of wealth characterize the reveries of children of all ages and adolescents, but the vision of wealth ceases to be of the fairy story type and the golden palaces, gorgeous jewels and dresses of the childish dreams fade and are replaced by those of a more materialistic character. Wealth is no longer imagined as the gift of a fairy godmother but as acquired through material agencies. Boys dream of acquiring a fortune by means of some wonderful invention, by going West and discovering a gold mine or by phenomenal success in business or speculation, but whatever the method, it is always a short and easy process. Girls dream of marrying millionaires, inheriting large fortunes from newly discovered relatives or of becoming famous actresses, musicians or authoresses and acquiring wealth along with fame. Frequently there is a strongly altruistic element in these dreams, especially during the early adolescent years. Hospitals are endowed, animal refuges established, public play grounds fitted up, fresh air work carried to an extent which quite dwarfs its present proportions, the poor are clothed and fed, and one young philanthropist would "give every boy a bicycle." The part which bicycles play in the consciousness of the American boy, and sometimes of girls, also, is astonishingly large. Those who do not possess them dream of having them, and those who have them dream of the good times they have had or expect to have. A boy of eleven writes:

"I dream most often of having hundreds of dollars and I go down and order two bicycles and have coaster brakes put on them. Then I bring down my brother and get the bicycles and order bicycle shoes and suits." Another, of fourteen: "I dream most of riding a bicycle. Once I dreamed that I and some other boys were racing. We had to go around the track three times and I won the race, the other boys coming in a few yards behind, and there were thousands of people looking on."

A few years later automobiles take the place of bicycles and the desire to own one is wide-spread though not as universal as in the case of the bicycle.

The following dream so completely sums up the various sports indicated in the "good times" of day dreams that it is given entire.

M., 14½. My day dream is if I had $16,000,000 I would have a couple of red devil automobiles, a couple of air-ships, and a fine big mansion. I would have a couple of hundred nice carriage horses. I would hire a couple of hundred of men to take care of things and keep everything looking swell, and a swell big building for playing in-door-base-ball in winter, Basket ball, Ping Pong, Rugby, and all kinds of sports and games. The first thing I would do before I ate my breakfast would be to go out and have a nice swim and then take a good pair of

Arabian horses and take myself out for a ride and then come back and eat a good breakfast and take one of my red-devil automobiles out for a good ride.

A more modest dream by a boy of the same age is "I would like to have a snug little cottage by the sea, and have a small yacht and few row boats and be able to go out in them whenever I please."

With the average healthy boy from ten to fifteen a large part of his day dreaming appears to be connected with sports and athletics. When tired or not interested in his school work he is apt to take refuge from *ennui* in visions of fishing, gunning, marbles, base ball, swimming, camping, boating. Even when these amusements have little likelihood of becoming realities, he still conjures up visions of what fun it would be if he could have them.

Base ball furnishes the content of many day dreams for boys from twelve to sixteen. The character of the dream varies from reviewing a recent game in all its details or anticipation of games in the near future to dreams of greatness as a famous pitcher in which the applause of admiring multitudes is vividly pictured. In some cases the dream is so vivid that incipient movements connected with the game are made.

M., 13. One day in school, I got to thinking what a fine time I would have playing ball after school. I dreamed that I was a fine pitcher in a team and the other boys were glad to let me pitch.

M., 13½. My dreams are mostly about ball games and I don't enjoy them very much because they make me think I am a whole lot and then when I wake up I'm nothing but a boy that can't play very well at all."

Dreams of hunting, fishing, swimming, being a cowboy and living on horseback and travelling in unexplored countries are characteristic throughout the teens. Some of these dreams are entirely unconnected with experience while in others the mental imagery is largely furnished by memories of vacation pleasures. The instinct itself appears to be widely spread and independent of environment, since it is apparently as strong in those who have never been outside a city as in those who have had opportunities for gratifying it. Very few girls have these dreams and they are usually in the form of wishing to be a boy so that such things were possible. Girls dream of travel as much as boys, but when details are given they are of comfortable, civilized travel and rarely include elements of adventure. Country life and animals also figure largely, but very few drift beyond the bounds of convention in their imaginings. The chief form in which any inclination toward adventure appeared was in the dream of being a red-cross nurse and going to China or the Philippines.

Dreams of fame and future greatness rarely occur before

adolescence. They vary from vague dreams of achieving honors in military or naval service, law, medicine, politics, music, acting, winning social or business success, to the attainment of some coveted school honor, having the highest works, gaining honors at graduation or being a leader in athletics. To the boy looking forward to college the highest pinnacle of fame seems often to be the attainment of captaincy of a football team. In children the desire for self recognition and aggrandizement demands immediate fulfillment and is rarely projected beyond the immediate future, while to the adolescent the vague future seems to possess special attraction and this distinction seems to hold throughout all dreams of the future. A child's vision of future pleasure is usually bounded by "next Saturday" or the nearest vacation, while the adolescent range seems to include past, present, and a boundless future. An apparent exception to this occurs in children's dreams of being grown up, which are very common, but when these are described in detail they almost all prove to be of the fairy story order and not a real looking forward into the future. The content of these adolescent dreams of future greatness are chiefly dependent upon environment and personal ambitions. Some are a mere expression of desires without expectation of fulfillment while others show evidence of being a distinct source of inspiration for purposive effort. Several writers state that when tired or discouraged they found in these dreams of future success encouragement and inspiration for further effort.

F., 13. My day dream is mostly about being an actor in an opera company. I dream of being a beautiful singer.

F., 13. Sometimes I dream of being an authoress and travel all over Europe and Asia, writing about the different peoples.

F., 15. My day dreams are of being a fine pianist and having people overwhelmed by the beauty of my playing.

M., 15. Dreams of becoming the champion ball player of the world.

M., 16. Dreams of military greatness and becoming a great general.

M., 19. I dream of future greatness. I do not think my day dreaming an evil because it places before me an ideal to strive for.

F., 18. I dream of becoming famous as a writer or actor or other impossible person.

M., 19. As I have always wanted to be a lawyer, my air castles have always been of palatial law offices, stump speeches. Congress and the inevitable White House vision looms in the background. Every boy dreams of the presidency. I see myself delivering a powerful speech before some large audience, with roars of applause interrupting. I think it a bad habit and wish I could stop it. It interferes with study and makes me dissatisfied with reality.

M., 18. Dreams of becoming a famous engineer and overcoming great difficulties in problems of construction of bridges and railroads. Never dreams except in leisure time and thinks that he works the harder because of these dreams.

From the age of twelve the influence of books upon the content of the day dream becomes increasingly important. With

the less imaginative the dream may be merely a reproduction, with slight alterations, of some book recently read, but in other cases the book simply furnishes the raw material out of which the fabric of the dream is woven. Girls put themselves in the place of their favorite heroines and adapt the material of romance, poetry or travels to their own uses. Their ideals of life are affected by what they read. Some of these dreams of the future are visions of beautiful and useful womanhood, but the trail of the Elsie books, with their morbid religiosity, and the influence of the Duchess and Rhoda Broughton is evident with unfortunate frequency. Boys dream of fighting indians, having hair breadth adventures on land and sea, being cowboys, pirates, brigands or national heroes as the case may be. Detective stories seem to acquire a peculiar charm at about the age of fourteen. The best of these do not apparently exercise any particular harmful influence and they appeal strongly to the logical instinct which seems to acquire prominence at about this age. But of the baneful effects of the worse class of this literature there is no doubt. Boys become familiar with the details of sin and crime before their moral ideas are fixed. The qualities of courage and hardihood involved in certain forms of crime appeal strongly to their imagination and many cases of juvenile crimes are directly traceable to literature of this sort. A more common effect is the lowering of ideals of manly honor and pure mindedness and the taste for emotional excitement which renders other literature tame and uninteresting and destroys interest in school work.

Another type of day dream common to both children and adolescents is the story making impulse which in some cases reveals a high type of creative imagination.[1] Some children regularly get themselves to sleep by making up stories, the same one sometimes being continued for several nights. The frequency of the continued story was, however, very small, forming in the present collection of data less than one per cent. of those mentioning the story form of dream.

F., 17. When eight or nine years old I used to sit at the window and make up stories about people who passed.

F., 18. Once when I was about thirteen years old, I was sitting in the twilight rocking the baby's cradle. I felt sad and lonely and singing softly to myself I made up a song about my husband being far across the ocean and never would he again come home to his loved ones; then it ended by his sudden home coming and joyful welcome.

F., 18. My day dreams are in the forms of imaginations in every way remote from my surroundings. They are somewhat in the form of a story whose incidents and scenes are continued from time to time. I have recorded some of my day dreams in the form of stories.

[1] The Continued Story, Mabel W. Learoyd. *Am. Jour. of Psy.*, Vol. VII, p. 86, 1895.

F., 18. My day dreams frequently deal with some adventure in which I am taking an active part. They are like stories and unfold themselves gradually. Since childhood I have been in the habit of putting myself to sleep with these dreams.

F., 19. My day dreams have always been stories. I used to get my little brother to sleep by telling my dreams. I still dream stories, and sometimes I dream of becoming famous.

F., 30. I have since a small child put myself to sleep nightly by spinning stories of adventure, romance, and travel in which I was the chief actor.

Closely akin to the story form of day dream is the imaginary conversation which is sometimes carried on with actual friends and acquaintances, sometimes with strangers casually seen or with characters in books or history, or in some cases with purely imaginary characters. Some novelists and dramatists have done much of their composing in this form, and these imaginary characters acquire a vivid personality. Lonely children sometimes develop this form of imaginary companionship. Some years ago Dr. G. Stanley Hall collected a number of cases of these imaginary companions and the records are given with considerable detail. All began at an early age, usually as soon as the child began to talk, and continued for several years, usually until the child began to go to school, or was otherwise brought into contact with children of the same age. One child, a boy, began to play with an imaginary "Gobby" as soon as he could talk and when nearly five "Gobby" was still his constant companion, but had grown up and had a wife and daughter, who were also playmates. Another child of about the same age had two imaginary playmates, one of whom was responsible for all his bad behavior, and the other played the part of his good genius. His probable behavior could often be inferred by noticing which of his imaginary companions was in evidence at the time. A few years ago in one of our popular magazines, there appeared some letters purporting to be written by a child of eleven to her husband whom she assumed to be somewhere in the world though she did not know him.[1] Whether these letters are, as they purport to be, the genuine productions of a child, or later reminiscences put into this form for literary effect, they picture with psychological truth the impulse of a lonely and imaginative child to find in an ideal world the sympathy and companionship which was lacking in the outward life.

Day Dreams of Love and Marriage are frequent after the age of seventeen, and occasionally earlier than this for girls. Sometimes these are vague dreams of a happy future with a shadowy partner who is to possess all virtues; sometimes there is a defi-

[1] A Child's Letters to Her Husband, Helen Watterson Moody. Maclures, Vol. XIV, p. 55.

nite picture of a future home and a house is planned and furnished in all details. With girls, unless they are definitely looking forward to marriage, the house planning and furnishing is usually of a luxurious character and without reference to probability. With boys this vision of a home is more apt to be controlled by the possibilities of achievement. Both boys and girls frankly acknowledge dreaming over their friends of the opposite sex, though the more elaborated romances are nearly always woven about comparative strangers or wholly from the stuff of which dreams are made. Many girls imagine themselves in a home with children to whom they give names and even picture the color of their eyes and hair, how they shall be dressed and educated, and the good times they shall have, while the shadowy partner of these joys is rarely visualized or very definitely characterized. A few samples of this type of day dream are given.

F., 18. I dream of being married and having a beautiful home of my own. I picture to myself the arrangement of the rooms. And the prettiest room in it will be a nursery furnished in pink and white and occupied by a curly headed little boy and girl who will be the dearest children in the world.

F., 17. My day dreams are usually about my future life: if I were married and had a home of my own and how cosey I would keep it.

F., 18. Dreams of certain friend, recalls all he has said in conversation, plans their future together, etc.

F., 19. My day dreams are mostly of a sentimental character.

F., 22. My day dreams are apt to be about some whom I have met or to whom I am greatly attracted. Sometimes I dream of being married and having a home. Sometimes I write imaginary letters.

F., 17. Sometimes I dream of meeting my future husband, falling in love with him, etc., and how I would love and care for my children.

F., 20. I do not have much time for dreaming now. I used to imagine the pleasure of having a little home in the country with mother. I know that I ought not to worry, so try to keep those thoughts out of my mind.

F., 19. I seldom have time to build castles in Spain but when I do I am not different from most southern girls, *i. e.*, my dreams are usually about a pretty fair specimen of a six foot three inch biped.

F., 20. I nearly always dream of myself as being very famous or at least holding an honored position. I have dreamed of being a teacher, a trained nurse, the head of some great medical institution, or a great speaker. I never dream of being a wife and mother. I cannot say why, but perhaps because I am not a pretty girl but decidedly homely.

F., 18. There are times occasionally when I think how nice it would be to be married and have a home of my own, and I think of the joy it would be to train up a little child and know that he was your own.

M., 17. My day dreams are sometimes of having a home, a loving wife and children and the means to keep them in comfort.

M., 23. As for day dreams I rarely indulge in them, don't have time. I fill my spare moments with thinking of my sweetheart.

M., 25. My day dreams are usually of her whom I hope to make my wife. I have visions of our future home life together and they are an inspiration to better living and more earnest effort.

M., 21. My day dreams are generally of what I am going to do in the future (of course a certain pretty girl plays an important part).

M., 25. My day dreams are generally made up of plans by means of which I hope to make my sweatheart my happy wife. They are not mere love dreams but contain all the essential elements that go to make professional life a success. My dreams are of reaching the highest point in my profession and making my wife happy.

M., 27. My chief day dream is of a beautiful home and an angelic wife.

The house planning form of day dream is of frequent occurrence even when not connected with dreams of love or marriage. There are many of both sexes who seem to have a sort of architectural instinct and find recreation in planning not only houses but grounds and even extend their fancies to landscape gardening and poultry raising.

A more prosaic form of dreaming is that in which the future occupation as a means of livelihood is the content of the dream. With the children of the poor, this is influenced by probability at an early age and the natural instincts for activity and out of door life find little play. Both boys and girls of eight or nine look forward to earning money as soon as the legal school years are completed. Those who are able to remain longer in school look forward to nearly every possible range of occupation. The number of occupations mentioned by boys is naturally greater than by girls, but the latter mention nearly every occupation open to women, including teaching, nursing, stenography, bookkeeping, dressmaking, millinery, work in a store, etc. In most cases there were pleasurable anticipations connected with these images of the future either because of expected enjoyment in the work itself or because of the prospect of earning money, often with desire to benefit others.

Opinions as to the Rightness or Wrongness of Day Dreaming.

The youngest children who wrote their day dreams (those of the third grade ranging in age from seven to nine) had evidently not thought of a moral aspect of day dreaming and either gave no answer to the question or expressed surprise at its being asked. One child answered: "No one ever told me it was wrong;" and two or three others thought that it was right it the things dreamed about were true but wrong if they were not. The papers of the children giving this answer showed rather a high degree of imaginative power and it would be interesting to know whether they ever told their dreams as facts. Several reminiscent papers mention the confusion of fact and fancy in childhood, and one girl of eighteen states that at the age of fourteen her day dreams were so vivid that she sometimes told them as facts. In all grades higher than the third,

day dreaming and inattention to lessons seem to have become inseparably associated and the answer is apt to be of the stereotyped form that day dreaming is wrong in school "because you ought to be attending to your lessons." But in addition to this reply many children appear to have done some independent thinking and give individual reasons for thinking the indulgence right or wrong. Day dreams are wrong if they are about bad or mean things, wrong "because they make you feel cross when you are interrupted," "because they make you dissatisfied with what you really have," "because it is wrong to wish for what you can't have," "because they waste time." They are *not* wrong "because they are natural," "because they can't be helped," "because they are about pleasant things." They are right because they make you happy, make you forget your troubles and worries and because "they rest the mind." Typical specimens of the answers given at different ages are given.

M., 11. I do not think it is right to let your minds wander off. Sometimes my mind will wander off. I will not know what I am doing. When I try to think, it is very hard to think. Sometimes it will be a long time before I can think what I am doing.

F., 13. Day dreams are wrong because they make you feel cross when you are aroused.

M., 11. "I think children should try to stop themselves from having day dreams because when you are dreaming like that in school you might miss a whole lot of lessons."

F., 12. Dreams oftenest of her brother who is dead. "My dream is wrong because my brother is dead and of course could not speak to me."

M., 12. I think it is one wrong thing nature lets us do because you might want to do something very bad and sit down and dream away your time.

M., 14. I do not think day dreams are right because the more you let your mind wander the more you want to be there and know you cant.

F., 15. I think day dreaming is wrong because I have not very much thinking power and I think they use up a good deal of it.

M., 15. Last year I would sit in school and think of everything but my lessons. I failed on the final examination.

M., 13. I think these dreams are wrong and one ought to guard against them for when you get bigger they will happen more often and then people will call you dreamy head.

F., 18. "I think they are wrong because they weaken the mind."

F., 20. I think those that I do not enjoy are wrong, since in them I often attribute less generosity than I should to those with whom they are connected.

F., 12½. I think too much day dreaming is not good for anybody but when there is nothing else to think about they are very good things to have for they keep the mind off dwelling on troubles.

F., 13. I do not think my dreams are wrong for I hardly ever think of anything wrong.

M., 13. I think them right because it don't hurt you any to think, but I think it does in another way, this is in letting your mind go where it wants to, not taking care of its own business.

F., 14. I don't think them wrong if they aint about things which could make anyone do wrong.

M., 14½. I think they are right unless you ought to be doing something else because then you are not thinking of tricks to do and they keep you out of mischief.

F., 12½. They always seem right to me because nothing happens like the things I dream.

M., 13. My dreams are always right because they are true and always happen or are happening when I dream.

F., 15½. I think these dreams are all right because they do not hurt anyone. They are just childish thoughts.

M., 12. I think they are more right than wrong because when you are sad you could sit down and dream and forget your sadness.

F., 14. They give your mind a rest a great many times, but sometimes they take your mind off what you ought to be doing.

F., 17. I do not think day dreaming wrong unless carried to excess, and furthermore I think it encourages me.

M., 18. I do not think them wrong when I have leisure for them. When tired I like to let my mind drift away because I think it refreshes me and stops all the worries I may have.

F., 18. I enjoy day dreaming very much but I sometimes think it is wrong for it is apt to make you dissatisfied with your present life.

F., 18. I do not think it wrong to day dream. It gives one something to have as an ideal object in life. He plans his life in many instances according to his day dreams. Even if he is never able to carry out all his dreams, they give him a great deal of pleasure.

F., 19. Day dreams are often an inspiration to higher things. They sometimes lead us on to try to reach our ideals.

M., 19. This day dreaming seemed to force itself upon me. I tried hard to resist it because I thought it injurious to my mind. The more I day dream the harder it is to come back to reality.

Only a small per cent. of children above the fifth grade (10 to 12 years) and adolescents say that day dreaming is right without qualifying the answer in some way. "It is not wrong unless" or "right when it does not interfere," etc. Many adolescents give an unqualified "wrong" in answer to the question basing their answer upon personal experience. Some state definitely that their power of attention has become so impaired that any work requiring effort or continuity of attention is difficult and irksome. Others, taking a broader view of the subject, consider that while excess is harmful, a moderate indulgence under proper conditions of time and place is restful to the mind and, in some cases, is an inspiration which tends to widen the mental horizon. The insidious tendency of day dreaming to usurp the place of other mental activities, is, however, very generally recognized by adolescents and adults, and those who most fully recognize its value as a normal rest and relaxation of the mind or the soil from which real creative work may spring, appreciate as well the danger that the servant may become the master and mental imagery control the mind even in opposition to an effort of will.

Relation of Mental Images to Day Dreaming.

[1]Galton was the first to call attention to the great difference in character of the mental images in different individuals, his investigations showing that while some persons can call up mental pictures which are distinct and vivid in color and outline, others are so deficient in this power that the term mental image appears to them a mere figure of speech. Galton found that philosophers and those accustomed to abstract thinking were apt to be deficient in this power while children were likely to possess it in a high degree. He also found the visualizing power to be somewhat higher in the female sex. Binet,[2] following to some extent Galton's method, has gone somewhat farther and made a study of the degree to which mental images are under the control of the will. In addition to his more general investigations, Binet had two subjects (sisters) whom he studied with great care through a series of years and in whom there was a marked difference of type. Both were able to call up visual images though one did so with greater effort, her images were less complete than those of the other and she had little power to alter or transform them. When, however, the images were allowed to arise spontaneously, as in the more passive forms of day dreaming, there was great variety and richness of imagery. The younger had exceedingly distinct memory images and possessed the power of voluntary control over them in a high degree, altering them quickly and easily in accordance with suggestions made by the experimenter. Her mental imagery was, however, almost entirely lacking in spontaneity, and she seemed unable to comprehend that these images could arise apart from an act of will. Both of these types were abundantly illustrated in the present material. Many children described the succession of mental images which passed through their minds, said that they came of themselves and could n't be helped. Some described day dreaming as "queer" or "funny" because you never could tell what was coming next. Others described their day dreams as a definite reproduction of scenes which they had especially enjoyed, or said that they had some favorite day dream which was voluntarily initiated. Still a third form of day dreaming in the broader sense is illustrated by the insistent imagery which appears even in opposition to the will, as in the case of a boy who said that he did n't enjoy day dreaming because the one which came oftenest was the repetition, with all its details, of an accident in which he had seen his uncle injured. Dramatic authors sometimes have trouble with

[1] Francis Galton: Inquiries into the Human Faculty, London, 1883.
[2] L'Étude Experimentale de l'Intelligence, A. Binet, Paris, 1903.

their characters who persist in behaving in a way quite in opposition to the ideas of their creator. It is probable that these insistent ideas, which are usually connected either with some emotional shock or strain or are an accompaniment of over-fatigued states, approach very near to the line of morbidity. The relation of the will to day dreaming, as seen from the children's point of view, is of interest in this connection. Some say that day dreaming is not wrong because "you can't help it and what you can't help can't be wrong." Others say that they "can't help it sometimes" especially if tired or not interested. One boy says that he can't help it in school but is never troubled that way when the subject is base ball. Many state that they voluntarily initiate day dreams as a means of passing the time when lonely or uninterested or as a refuge from unpleasant actualities.

Relation of Day Dreaming to the Creative Imagination. There are a few adults who say that they never day dream but their papers show that they have restricted the meaning of the word to an exercise of the imagination which has no foundation in fact and which has been set aside as a childish mode of mental action. In the broader sense of the term it is probable that every normal mind exhibits certain automatisms in its reproductive activities, whether these be unaltered memory images or imaginative transformations and combinations which are a true creative activity. The richer the content of the mind, the greater the variety and spontaneity of the day dream and the greater the possibility that from its automatic working new and original combinations may arise. A psychological study of inventors would probably reveal the fact that many of the great inventions, though sought and worked over for years have come, at last, in a flash of insight through the automatic working of a mind filled with all the possibilities of the subject. Indeed we know this to have been the case with many scientific discoveries; and the biographies of artists, authors and scientists emphasize the fact that many of them have been day dreamers in boyhood, but always along with this has coexisted the fact of special interest and activity along some particular line, even though there were deficiencies in other directions. Herbert Spencer has recorded in his autobiography the fact he was, during his boyhood, "extremely prone to castle building" and that the habit continued even into mature life. This habit, while usually indulged in at bedtime, was frequently a course of annoying absent mindedness. In later years he wrote: "I believe that it is a general belief that castle building is detrimental; but I am by no means sure that this is so. In moderation I regard it as beneficial. It is a play of the constructive imagination, and without constructive imagination

there can be no high achievement. I believe that the love I then had for it arose from the spontaneous activity of powers which in future life became instrumental to higher things."[1] Many facts from the biographies of the world's leaders can be adduced in support of this opinion of Spencer's, and it may well be questioned whether too vigorous a pruning and repression of this play of the imagination is good pedagogy and whether a certain amount of this mental recreation is not necessary for mental growth. We know that music, art, and literature are much indebted to the great dreamers. But the mind must first be well stored and there must be energy for the realization of the dreams. It is never to the idle dreamer that the creative impulse comes. Mozart and Raphael were dreamers, but the harmonies of the one and the visions of the other belong to the world only because their dreams received embodiment by alliance with the drudgery of practical work. Napoleon and Mohammed were, each in his own way, dreamers, but they were also men of action. To Gautama, only after years of mental striving came the perfect rest and the vision of Nirvana. It is probable that to most artists the vision beautiful comes when the mind is passive and visual images rise unbidden, and literature owes much to that spontaneous play of imagery which is one of the characteristic forms of day dreaming. We do not need to recall that strange fragment of Coleridge's dream, Kubla Khan to realize that the brains of poets have sometimes worked in an automatic way. The day dream shades by almost imperceptible gradations through hypnogogic states to the dream of sleep, and, as those whose mental content is fullest are those who are apt to dream most, so with the day dream. Babies and idiots probably do not day dream as they have not a sufficient store of mental impressions for reproductive combinations. And among those whose lives are a monotonous round of toil in the bare struggle for existence, there are probably few dreams either of the day or night, because little material is furnished by the environment. Experience having bred few images for the fancy to work upon, release from bodily exertion is followed almost immediately by sleep. The effect of monotonous labor in dulling mental images, even in well stored mind, is noted by those who have spent years in Siberian prisons, even the images of home and friends being no longer recalled with clearness.[2]

Enjoyment of day dreaming in itself considered, except in those cases which are either morbid or tend to become so, is universal. The few who say that they do not enjoy it invari-

[1] An Autobiography; Herbert Spencer. New York, 1904.
[2] Sixteen years in Siberia; Leo Deutsch. London, 1904.

ably give as a reason, conscientious scruples in regard to it as the factor which disturbs enjoyment. Children occasionally give some unpleasant consequence resulting from the habit as a reason for non-enjoyment but nevertheless do not discontinue the habit. Some say that day dreaming is their greatest pleasure and that they "could not live without it." Even sad dreams are enjoyed, the sadness being of the same nature as that evoked by seeing a tragedy on the stage or reading a book which may be thoroughly pleasurable even though the reader is reduced to tears. Emotions in day dreams of a normal type are all attuned to a low key, due, perhaps, to the relaxation of the muscular and vascular systems. Mosso[1] found experimentally that respiration tends to become periodic, and the pulse is lowered when attention begins to wander in states of drowsiness and in the dreamy states when attention is most completely dispersed. Twilight moods of reverie are typically characterized by the more subdued emotions and by moral and religious aspirations.[2] The mood is generally enjoyed and many say that it rests and helps them.

MORBID DAY DREAMING.

In cases of morbid grief and painful reverie instead of muscular relaxation there is sometimes a partial paralysis and rigidity of the muscles which is apparent in the face and hands, and in the character of the movements when the subject is aroused. These cases of painful reverie are reported chiefly by adults and are sharply distinguished from the enjoyable melancholy and "sweet sadness" of normal reveries. The content is not an imaginary situation, but some actual sorrow or trouble, and the tendency to morbidity is frequently recognized by the subject, and is shunned by an effort to keep the mind occupied with other things. In cases of physical weakness and ill health, these reveries tend toward, and in some cases become obsessive ideas against which the patient struggles in vain, whenever physical weakness prevents constant occupation. Scenes which crush the heart and paralyze effort are relived again and again and the will is powerless to banish these images which the patient may fully realize are leading to mental degeneration. In the entire number of day dreams collected from children only thirteen morbid cases occurred as regards content, though there were a number of cases in which, though there was no morbidity of content, day dreaming had become

[1] Fatigue; A. Mosso, translated by M. and W. B. Drummond. London, 1904.

[2] Reactions to Light and Darkness; G. Stanley Hall and Theodate L. Smith, *Am. Jour. of Psy.*, Jan., 1903.

so excessive and so imperative a habit as to be regarded as a morbid development, very closely approaching the effects upon some hypnotic subjects in the loss of will power. Among the cases of morbid content two were of snakes. Both subjects were boys and in one case the cause was stated as due to a fright which had generated a morbid fear which resulted in images of the object dreaded whenever the mind was allowed to wander uncontrolled. In the other case, no information was given beyond the fact that day dreams were always of snakes and not enjoyed. Two children of thirteen and fourteen dreamed of dying and of the end of the world, and in one of these cases the tendency of the dream to become an imperative idea was marked. Two others habitually have sad day dreams and in both of these cases the health was reported below normal.

F., 12½. When they are nice and not frighting I enjoy them, but when they are horrible and frighting I do not like them.

F., 13. My dreams are most often different but about something sad.

M., 14. Day dreams chiefly of snakes of which he is afraid.

F., 13. When I am sewing or reading, I begin to think. I think and think about everything until I think about something I cannot get off my mind. One thing I dream about most is the end of the world. I wonder what will become of the people and how the earth will look and how dreadful it will be.

F., 14. I always think about the past and what if I should die.

F., 19. I am a victim of day dreams to a most annoying degree insomuch that all efforts at resistance seem futile.

F., 39. Has met with great loss and sorrow; sits for hours in the same rigid attitude, with eyes fixed on vacancy. When aroused makes an effort to attend to things about her but if left alone sinks back into the same attitude. The images of her sorrow are constantly before her mind.

Sir James Crichton Browne[1] inclines to the view that all dreamy mental states have a morbid tendency. He acknowledges that in otherwise healthy minds no harmful consequences either mental or physical can be detected. He quotes various cases in connection with nervous and mental diseases, such as the dreamy state which sometimes forms a distinct aura in epilepsy and argues that men of genius known to have been subject to these dreamy states have suffered injury and been hampered in their work by them. As an extreme example he quotes the case of John Addington Symonds, the historian of the Renaissance, who suffered from a peculiar dreamy state which he thus describes. "Suddenly in church or in company, when I was reading and always I think when my muscles were at rest, I felt the approach of the mood. Irresistibly it took possession of my mind and will and lasted what seemed an eternity and disappeared in a series of rapid sensations which

[1] Dreamy Mental States. London Lancet, July 13, 1895.

resembled the waking from an anæsthetic influence. One reason I disliked this state was because I could not describe it to myself. It consisted in a gradual but swiftly progressing obliteration of space, time, sensation and the multitudinous factors of experience which seem to qualify what we are pleased to call ourself. At last nothing remained but a pure absolute self. The universe became without form and void of content." This description is very closely analogous to those states sometimes experienced in extreme fatigue when, for an instant, the mind seems to stop working and then goes on. It differs from unconsciousness in the fact that the blank is felt though no effort of memory can recall any mental content. Such states are merely results and symptoms of extreme fatigue, and unless the fatigue be sufficiently prolonged so that the nervous system loses its normal recuperative power, have apparently no more serious consequences than any other fatigue states. As in the 1,080 cases furnished by the graded schools all the children present wrote and with the few doubtful exceptions already noted day dreaming was reported by all the children with a very small percentage of morbid tendencies, there seems to be no ground for the assumption of any morbid connection, either mental or physical, with day dreaming *per se* more than with any other mental activity. If morbid cases are sought they are not difficult to find either in the form of morbidity of content or excessive indulgence, resulting in loss of will power, or cases in which both factors are combined. Féré[1] cites an interesting case of a man who had been from childhood an inveterate day dreamer to an extent which seriously affected his college course. He had pursued in his dreams a number of fictitious careers, military, marine, engineering, etc., which he seemed to prefer to real life. On leaving college, however, he engaged in an active business career, was happily married, successful in his undertakings, and having no time for day dreaming, seemed to have overcome the habit. A few years later, however, he began to suffer from insomnia and at the same time became dissatisfied in regard to his business and household affairs. He took refuge in his former imaginations, and though these were less absorbing than formerly they gradually became more persistent and finally acquired a fixed form in which he lived an ideal life in a chateau which he gradually elaborated. He acquired an imaginary wife and children and manifested less and less interest in his actual family. He continued nominally to conduct his business, which, however, was really managed by his staff of employees. Finally, on an occasion when some one accosted him by name and wished to

[1] Pathology of the Emotions; Ch. Féré. London, 1899.

confer with him on business he replied "He is at Chaville," the name of his imaginary chateau. This betrayal of himself in public, however, startled him into a realization of his actual condition, and fearing himself insane he was ready to do anything to banish his ideas, but found that they had become his masters and that against his will he constantly relapsed into his dreams. After three months of medical treatment, with strict supervision night and day to prevent any lapse into dreaming, he recovered. In this case visual images appear to have played an important rôle and the subject was of a strongly visual type. Whether in this case, the day dreaming was the cause or result of a diseased mental state is uncertain, but the suppression of the dreams was an important factor in the treatment which resulted in his recovery. As to the danger of day dreaming in a normal individual the following testimony of a man of twenty-six, who has carefully analyzed his own case, is of value. A. B. remembers that as early as the age of eight years he was a dreamer and says that his day dreaming has been the happiest part of his life but that "it has made it very hard, sometimes next to impossible, to pay attention to anything dull or abstract." All the will power I can bring to bear only serves to pull my mind back to what it ought to be busy with instead of keeping it steadily focused there. If one could dream up to the limit when one ought to dismiss it entirely and attend to the sterner things of life, I think day dreaming would be a veritable gift from the gods. But it is a curse when the habit becomes so fixed that a man can't pay attention to things which perchance have little natural interest for him."

The tendency of day dreaming to become habitual and excessive is, in the present study, most marked in those who have strong visual imaginations, yet the power is in itself a mental gift even though it sometimes prove a dangerous one. The great literary and religious dreamers have usually been men whose visual imagery was exceedingly vivid. Dante, Milton, Mohammed and Swedenborg were all endowed with all the power of visual imagination to an extraordinary degree. Many drugs owe their peculiar fascination to their power of intensifying sensory images and producing dreamy states. The Mexican drug, mescal, the use of which as a religious cult among the Southern Indian tribes of the United States has spread in spite of efforts to restrain it, has for its chief mental effect the production of colors and forms of wonderful variety and intensity. The muscular relaxation noted as characteristic of day dreaming is produced by all anæsthetics and where the oncoming of unconsciousness is not too sudden the mental states preceding are closely analogous to those of day dreaming. De Quincy, who more vividly than any other writer has

depicted the effects of opium, emphasizes the impairment of muscular power and corresponding weakness of will. The effect of nicotine in producing dreamy mental states is too well known to need description, and teachers report that boys who are addicted to cigarette smoking are invariably dreamers and defective in the power of voluntary attention.

In summarizing the results of the present study, attention is drawn to the following points:

Day dreaming appears to be a normal and well nigh universal phenomenon in children and adolescents and may continue throughout life. It is especially characteristic of the years of adolescence.

The content of the day dream is chiefly determined by environment, though its forms, like those of night dreams, are influenced by age, health and degree of mental development.

In early childhood, day dreams, except in the case of exceptionally imaginative children, are made up chiefly of memory images, actual experiences or stories being reproduced with little change. This tendency to reproduce memory images unchanged is evidenced not only by the day dreams reported, but is further illustrated by the insistency of children that stories told to them shall be repeated without any change in the details, a fact familiar to every one who has had experience in telling stories to children. The future of childhood is usually a definitely circumscribed and near future, and motor activities and eating figure largely in the content of childish dreams.

With the dawn of adolescence there is a marked increase in the variety and complexity of content and the range is greatly widened. Dreams of the future are oftenest of the vague future with boundless possibilities. The instinct emotions become an evident factor and dreams of love are characteristic at this age. Both altruistic and egoistic emotions are greatly intensified.

Though comparatively few day dreams were collected from adults, the content of these indicated a somewhat closer connection with actual life than those of childhood and adolescence. Dreams of the future were more in the form of plans with the possibility of accomplishment either for self or others.

The few cases of the day dreams of old age were almost entirely memories of the remote past and much time was spent in dreaming. Since day dreaming is closely associated with fatigue states this appears to be the result which might be expected from mental and physiological conditions.

Though environment exercises an important influence upon the development of the imagination and there is a possibility that it may be dwarfed and starved by repression, much is due to differences of mental endowment, and day dreaming in a

marked degree is often associated with high intellectual endowments and creative ability.

Day dreaming, like any other mental activity, may become excessive and pass over into pathological states, and in consequence of the fact that it is usually enjoyable and a passive state, it is peculiarly liable to this source of danger.

Sex differences are especially marked in day dreams, many of them being so characteristically masculine or feminine that the sex of the writer is unmistakable. While this is in part undoubtedly due to environment and conventional training, it also suggests that in the more automatie workings of the mind there may be a fruitful field for the investigation of the question of how far mental differences between men and women are innate and fundamental and how far they are due to artificial causes.

REACTION-TIMES AS A TEST OF MENTAL ABILITY.[1]

By Guy Montrose Whipple,
Assistant Professor of the Science and Art of Education, Cornell University.

This paper is an attempt to show (1) that a distinction must be made between what may be called the 'laboratory' and the 'anthropometric' types of reaction experiment, (2) that many of the reaction-tests conducted upon school-children have not conformed to the usual requirements of the 'laboratory' method, and (3) that reaction-time tests, of whatever type, cannot be successfully used in tests of school-children, and fail to indicate mental ability. I shall not try in what follows to keep these propositions sharply distinct, or to keep to the order just given.

The interest in reaction-times as studied in the earlier investigations (incited by the phenomena of the 'personal equation' and Wundt's complication experiments during the early sixties) was directed very largely to the determination of the time-values themselves. But it was soon discovered that the results of different investigators failed to evince conspicuous harmony, even when the outward conditions seemed entirely identical. Thus attention was turned to the qualitative analysis of the psychical or psychophysical conditions governing the process of reaction. The treatment became qualitative rather than quantitative. Naturally many factors were unearthed,—some of them but little suspected in the previous work. It was found, for instance, that the simple reaction-time depended not only upon such objective factors as the modality of the stimulus, its extent and intensity, upon the nature of the movement of reaction, etc., but also quite as much upon certain more subjective conditions, such as the degree of fore-knowledge or expectant attention aroused in the observer, the presence or absence of a warning-signal, the length and uniformity of the interval between this signal and the stimulus, the presence or absence of distraction, the general condition of the nervous system as affected by drugs, fatigue products, etc., and, perhaps most significant of all, upon the direction of the observer's attention,—an influence cited by Orschansky in 1887, but still better known by the work of Lange soon after published.[2]

---

[1] A paper read at the Meeting of Experimental Psychologists at Ithaca, in April, 1904.
[2] *Philos. Studien*, IV, 1888, 479.

If we recognize the fundamental character of this distinction, we must always keep in mind the possibility of attention directed toward the reception of the stimulus (sensorial or complete reaction), toward the execution of the movement (shortened, abbreviated, motor, or muscular reaction), or more or less evenly poised between these two attitudes (central or natural reaction).

It has also been intimated, and is apparently taken for granted by many investigators, that the length of the reaction-time is further conditioned by age, by sex, and, finally by another factor, possibly further reducible, that of constant individual differences.[1] It is this last factor which deserves our attention because it has been assumed by more than one investigator that this factor is either identical with, or at least a function of, general mental ability or general intelligence, and it has, therefore, been proposed to measure the mental ability of school-children in part by determining their reaction-time. Are such constant individual differences to be established by careful experimentation, and, if so, do they give us an indication of the general mental ability of the observers who exhibit them?

In answering these questions it seems to me that attention must be called to the methods of using the reaction-test in the psychological laboratory and in the schoolroom. The typical reaction-experiment, as conducted in the modern laboratory, is a qualitative experiment: the emphasis, I mean, is placed upon the introspective examination of the observer's consciousness rather than upon the quantitative examination of the time-values themselves. The experiment calls for the synthetic construction of the action-consciousness. The chronoscope is employed partly to supply the objective conditions of the experiment (stimulus, movement of reaction, etc.), partly to keep some tag upon the work of the observer,—in a word, to standardize the conditions under which the introspection is made. If, for example, the times recorded for a series of simple auditory reactions are 180, 170, 190, 450, and 60 sigma, it goes without saying that the observer is inaccurate in his introspective examination if he reports a uniform series of conscious processes in all five tests: something else than the simple impulsive action consciousness must have been present when 450 sigma was recorded; something must have dropped out when 60 sigma was recorded.

Again, it is customary in the conduct of the laboratory re-

---

[1] The very term 'personal equation' has this implication, and may possibly have suggested the use of the reaction experiment in the way we are discussing.

action-experiment (at least in the Cornell laboratory) to give heed to the so-called 'types' of Lange. An endeavor is made, first of all, to establish the 'natural' type by avoiding, in the instructions to the student, any reference to the direction of the attention either toward stimulus or movement, and especially to avoid the suggestion that the reaction is to be made as quickly as possible. Now, experience shows that, if these conditions are established, many observers will, in their first reactions, adopt the 'central' reaction: this is, then, literally, their 'natural' attitude toward the experiment.

On the other hand, rather infrequently one encounters a student who belongs very clearly either to what has been termed the 'subjective' or to the 'objective, type of observer.[1]

We have here, then, a definite indication of constant individual differences, but it is not an indication from which we can argue at all to fundamental differences in general mental ability. We find merely that these occasional observers, who are extreme in their type, fall naturally into the sensorial or into the muscular type of reactors in the absence of more definite instructions.[2]

Obviously when these observers pass to the sensorial and muscular types of reaction and are instructed specifically how to direct the attention, they find the one attitude easy and the other difficult, according as their type is objective or subjective.

But a question of further significance now arises:—can those possessed of a strong *Anlage* (whether this is regarded as a

---

[1]This is a distinction which has received an increasing amount of sanction in the recent experimental literature, and which has been well described by Stern in his treatise upon individual differences. It must be reducible to a fundamental difference in nervous constitution, and has, therefore, appealed to me as being possibly identical with Ribot's attractive scheme of the temperaments in which the fundamental division is into the groups,—sensitives, actives and apathetics. The sensitives may be the subjectives, the actives the objectives.

[2]To quote from Stern: "One man is accustomed to take up an active attitude to everything that occurs to him: his own action is for him the constant point of interest, and his environment is of importance only in so far as it affects this centre of reference; he therefore keeps his personality, his 'I,' in instant readiness for action. Another is wont to submit himself passively to the operation of external impressions; he regards them from the theoretical point of view, is contemplative in disposition. The former is inclined to make himself 'ready for the leap;' his fingers are intense, and the psyche is intent; he merely awaits the signal for action. The latter tends as naturally to a sensorial direction of attention: if we force him to think of himself, and to dispose himself for the coming movement before the occasion for its performance has arisen, he feels confined and confused. The former is expecting his own outbreak, the latter is awaiting the impression; the stimulus is in the one case the release, in the other the cause of movement." *Ueber Psych. d. individuellen Differenzen*, 108, as quoted by Titchener, *Exper. Psych.*, Vol. I, pt. II, 215-6.

matter of ideational type or of type of attention) be taught or coached to exhibit both the sensorial and the muscular type of reaction? I am aware that there is evidence in the negative.

Professor Baldwin has published results from which he argues that observers possessed of strong ideational types give reactions consistent with those types despite all attempts at modification, and Messrs. Hill and Watanabe, from investigations in the Cornell laboratory, conclude that "if the volitional temperament is unfavorable, practice will have no effect in determining the two types of reaction-time."[1] Despite these statements, I have personally the conviction that, at least in the vast majority of instances, a constitutional tendency toward a particular reaction-attitude can be overcome by proper coaching. In any event, we have no evidence in these laboratory investigations that there exist any constant individual differences in reaction-time that depend upon general mental ability.

With the possible exception, therefore, of a few isolated and extreme cases, we may, in the conduct of the reaction-experiment in the laboratory, bring all observers to exhibit the two chief types of attention to the reaction. And now most important is this:—when practice is attained, as indicated by a mean variation less than 10% of the average or median value, the results, judging from my experiences in the laboratory at least, are practically identical for all observers. In other words, our constant individual differences have disappeared, since they themselves depended upon degree of practice and upon variation in the direction of attention. And so we may predict with some confidence that a practiced observer, under laboratory conditions, will give the following simple reaction-times:

	SENSORIAL	MUSCULAR
pressure	210	110
sound	230	120
sight	270	180

Those few observers who cannot be taught to exhibit both types will at least conform to these figures for the type to which they belong.

Turning now to tests upon school children and students, I wish to take for illustration the work reported by Bagley, Gilbert and Wissler. It needs but little argument to show that the results of any psychophysical test are largely influenced by the conditions under which that test is administered. The

[1] For further references, see Titchener, *Exper. Psych.*, I, Part II, 225.

conditions under which the reaction-time test has been used to determine the mental ability of school children are so unlike those just described for the psychological laboratory that I venture to term them 'anthropometric' as opposed to 'laboratory' reactions. Certainly the work of the first two investigators just named belongs in the former category. For we find that emphasis is placed upon the quantitative measurement of the time to the utter neglect of the introspection of the action-consciousness, and with the avowed intent of measuring the capacity of the subject as one might measure his skull or his physical endurance. In such tests the observers are, of course, entirely unpracticed, and no specific directions are given for the control of the attention. Moreover, probably in most cases, the pupil is given to understand, either explicitly or implicitly, that the reaction is to be made *as fast as possible*. These variations in the conduct of the experiment really *make another experiment of it*, and the results cannot be expected to coincide with those obtained in the laboratory. Hence the question must always be asked: how far are such tests reaction-times in the strict sense of the term, and, further, just what is actually being measured.

Bagley[1] attempted to relate mental and motor ability by the use of both experimental and non-experimental values. The experimental data for mental ability were the results of reaction-tests made with the aid of Jastrow's card-sorting apparatus.[2] These reactions are not, of course, simple reactions, but the method lends itself, nevertheless, to discussion in this place.

It will be noted that Bagley assumed definitely at the outset that these reaction-times would be expected to indicate mental ability. He says (p. 194): "the experimental sources of the data on mental efficiency consisted of various types of reaction-times as representing quantitatively the mental ability of the subject, mental excellence being represented by the alertness of the mind in reacting appropriately to given stimuli."

Glancing at his results, we find, however, that, by the method of correlation by groups, there is a discrepancy between reaction-times and class-standing, *i. e.*, the relation is not positively inverse, but indifferent. There follows, moreover, this significant clause: "the children whose reaction-times are nearest the norm have the best class-standing, while those who are particularly alert and those who are particularly slow in

[1]On the Correlation of Mental and Motor Ability in School Children, this *Journal*, XII, 193.

[2]It may be pointed out parenthetically that card sorting is open to numerous objections. In particular, the variable factor of the 'handling-time' cannot be adequately eliminated by mere subtraction, as I have convinced myself by personal trial.

reaction, are alike deficient in mental efficiency as represented by the class-standing." Now, would it not be plausible to modify this inference in this way:—the most intelligent children, as indicated by class-standing, are most able to follow instructions, and therefore to approximate the norm, while the less attentive children are erratic and prone to yield either premature or delayed reactions? This, it seems to me, is the true solution of Bagley's results.

Gilbert[1] tested school children of various ages, using a visual discrimination reaction (react to blue, not to red) and also a simple visual reaction. The results of the two tests were closely similar and may be considered together.

In his recent article upon the objective measurement of "General Intelligence,"[2] C. Spearman criticises Gilbert for not working out the correlation between reaction-time and mental ability by more exact formulæ, and explains the low figure which can thus be actually found as the result of the unfavorable conditions under which the procedure was made, the heterogeneity of the reagents, etc., with the final conclusion that the true correlations must be very much higher than those actually observed.

It seems to the writer that such criticism fails to reach the heart of the matter. How would Gilbert's results stand in the face of the rigorous standardization of conditions which we have found necessary in the laboratory? Is there any value in computed correlations from data which are themselves so loosely gathered?

For instance, it will be recalled that Gilbert argues at length for the use of the median-value versus the arithmetical average. He says that in a series such as 240, 230, 220, 250, 480, 430 sigma, etc., the median-value method is more satisfactory because the large variants, like 480 and 430, do not so much influence the final value, while their force is directed, as it should be, toward increasing the size of the mean-variation. But in the light of all we know of the conduct of the experiment in the laboratory, such variants as 480 and 430 ought not to be admitted to calculation under *any* method, for they are clearly not *bona-fide* measurements of the reaction-consciousness: they do not stand for, or measure, the same psychophysical process as the other values cited. Why, then, should they be classed with them for further treatment? In the laboratory they would be discarded,—not by the experimenter, but by the observer's introspective control. Inspection of Gilbert's tables shows that the median value is, well-nigh uniformly,

[1] *Studies Yale Psych. Lab.*, II, Nov., 1894, 40.
[2] This *Journal*, XV, 201 ff., esp. 280-1.

from 15 to 20 sigma shorter than the arithmetical average: this indicates the presence of a few large values like those mentioned in nearly every group of tests.

Again, suppose we compare the actual times with those given in the laboratory. The values for the older children range, in some groups, from 170 to 180 sigma (arithmetical) and from 155 to 172 sigma (median value). These values, then, are *less* than the *muscular* reaction-times of practiced laboratory observers. But can we stop here? Can we even suppose that Gilbert's school children were mainly giving muscular reactions? Despite the possible suggestion of reacting as quickly as possible, I feel sure that this was not the case, and for three reasons:

(1) The rapid, semi-automatic reaction is nearly always the result of practice and is not apt to appear in a short first series.

(2) It is well known that visual reactions, more than those of any other modality, favor the sensorial type in an unpracticed observer, on account of the necessity of sensory accommodation for the reception of the stimulus.

(3) Gilbert took express pains to foster the sensorial attitude in order to guard against premature reactions. This he did by placing the discrimination reaction before the simple reaction in the order of tests, in order thereby to engender a habit of watching the stimulus.

We may, therefore, look with some suspicion upon such curiously small average times as those recorded by Gilbert.

And, again, if we add to this that Gilbert's mean variations are far above the 10% limit allowed by the laboratory, we are assured that such values are practically useless as measurements of reaction-times. They illustrate very well what I have in mind as the divergence of the anthropometric from the laboratory standards of conducting psychological tests.

But, even assuming that these values represented trustworthy reactions, what evidence have we that they are correlated with mental ability? When we are told that 'bright' children react more quickly than 'dull,' though less difference can be made out in the case of the 'average' group, we find the quantitative support is afforded by the figures 207, 213 and 224 for the three groups. And how much within the limits of certainty are we when the statement that "the brighter the child the more quickly he is able to react with discrimination and choice" is supported by the values 401, 402 and 420 sigma for bright, average and dull children respectively?

From a gradual increase in the rapidity of the reaction with age, even if established, we cannot argue that the increase is attributable to increased general mental ability. Mental growth and mental maturity must never be confounded with mental ability.

The work of Wissler[1] presents an exhaustive treatment of the results of various physical and mental tests of students of Columbia University as compared with one another and with the class standings. The conditions under which reactions were taken in this series are evidently midway between the best laboratory conditions and the looser conditions of Bagley and Gilbert. The reagents are very much of an age, are presumably all of intellectual ability above the average, while the external objective conditions were those used in the psychological laboratory. On the other hand there is no record of introspective control. The tests were few in number (three to five from a set of five), and evidently somewhat hurriedly taken, as Spearman has surmised.[2] Wissler, however, shows clearly that reaction-times are useless as indications of mental ability or even, what is more surprising, of general alertness or readiness of thought or action. The marking of A's, the naming of colors, the execution of rapid movements, and the recording of simple associations (all tests which put a premium upon rapidity and general psychophysical facility) fail to show any significant correlations with one another,—a conclusion, as the author remarks, "out of harmony with all general belief." And the relation of reaction-times with class-standings is merely that of chance.

If our arguments have not gone astray, we seem bound, in the light of our discussion, to conclude that the reaction-test is quite without significance as a measure of mental ability (save in so far as a small mean variation might indicate a certain steadiness in the control and direction of attention). We see that the reaction-time of any observer is determined by a large number of more or less independent factors, and that, when these factors have either been eliminated or controlled, as they are in laboratory procedure, we have left no residuum of individual variation that can be turned to account in estimating the observer's general intelligence or mental ability.

May it not be, or rather, is it not certain, that many other psychophysical tests which have been employed in a rough and ready way, often by inexpert experimenters, especially in the tests conducted upon school children, are quite as likely to be vitiated by factors similar to those we have considered?

At the risk of a digression, I may cite, as an instance, the test of pitch-discrimination which Spearman[3] has just advocated as a universal and ready means for the estimation of "General Intelligence." After conducting tests in pitch-discrimination in the psychological laboratory under all sorts of con-

---

[1] The Correlation of Mental and Physical Tests, *Mon. Suppl. Psych. Rev.*, June, 1901.

[2] *Loc. cit.*, 283.

[3] *Loc. cit.*

ditions for more than three years, I am positive that the use of a monochord to measure pitch-discrimination, as was done by Spearman, is far too rough a method to use for this purpose. What, for example, shall we infer in regard to the general intelligence of the young lady reported by me in a previous study[1] who was totally unable to judge a half-tone when struck with the slightest unevenness of accent upon the piano, but who could, after a little practice, give a value of $S = 0.52$ vibs. when the Stern tone-variator was used, and the influence of disturbing secondary factors thereby eliminated? I cannot forbear quoting my previous summary of these tests of pitch-discrimination: "A typical unmusical observer, when placed under proper conditions, may discriminate pitch differences of less than three vibrations correctly in 75% of the tests, but if the stimuli are of relatively low pitch, if they are given without any preliminary 'warming-up,' if the time-interval between them exceeds four seconds, if they are given too briefly or in too quick succession, if they are of unequal intensity, or if they are presented simultaneously with one or more other similar stimuli, then discrimination becomes either difficult or quite impossible, and it may then remain impossible even when D is represented not by a few vibrations, but by musical intervals of one or two octaves and more."

We have here, evidently, simply another illustration of the proposition which I have attempted to establish in regard to the reaction-experiment, viz:—the results of a psychophysical test are determined very largely by the conditions under which the test is conducted.

Summary.

(1) The reaction experiment, as conducted in the psychological laboratory, is primarily a qualitative experiment for the synthesis of the action-consciousness. When due regard is paid to the objective conditions, to practice, and to the direction of attention, most observers can readily be trained to adopt any of the three types of attention. And, for a given direction of the attention, the quantitative results are uniform for all observers.

(2) The reaction experiment of the 'anthropometric' type, as conducted upon school children, is a rough and ready quantitative experiment, which has yielded results of very questionable value as adjudged by the laboratory standards. The constant individual differences between groups of children, which have been assumed in some studies to indicate differing grades of mental ability or general intelligence, are largely the products of faulty experimental conditions, and cannot, in any event, be

---

[1] This *Journal*, XIV, 297-304.

referred, either in theory or practice, to constant individual differences in mental ability.

(3) This examination of the reaction-experiment suggests that many other experimental studies of school children have been vitiated by the neglect of those cautions in procedure and interpretation that laboratory practice has taught. As an illustration, the pitch-discrimination of an unmusical observer is shown to be subject to wide variation when the test-conditions are modified but slightly.

(4) The outcome of the reaction-time test (and, indeed, of any psychophysical test) upon school children will, furthermore, depend not only upon the objective conditions of the test, upon the nature of the instructions given, etc., but also to an appreciable extent upon the ability of each child to understand and carry out these instructions. When, therefore, a test is affected in this way, any assumed correlation between the quantitative results and the general intelligence of the group of children tested is, in reality, but a correlation of general intelligence with itself.

STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF THE UNIVERSITY OF MICHIGAN.

CONTRIBUTED BY W. B. PILLSBURY.

VII. THE EFFECT OF STIMULI UPON THE LENGTH OF TRAUBE-HERING WAVES.

By C. E. GALLOWAY.

In two papers, published about three years ago, Dr. Slaughter [1] and Mr Taylor [2] showed that fluctuations of the attention stand in close relations to certain physiological rhythms, chiefly the Traube-Hering waves and respiration, and that they are considerably affected by sensory stimulation. These results suggested a series of experiments on the effect of stimuli on the Traube-Hering waves with a view to finding whether or not it coincided with the effect of stimuli on the fluctuations of the attention. The general aim was to secure, if possible, additional evidence for the theory that the two processes have the same physiological basis and also to determine the effect of pleasant and unpleasant stimuli upon one more physiological process. When these experiments were well under way Prof. Pillsbury, who was then investigating the relation of the attention waves to fatigue,[3] suggested a parallel investigation of the Traube-Hering waves to determine whether or not they showed a "diurnal periodicity corresponding to that noted in the attention waves." Accordingly a series of plethysmographic tracings were taken from five of the subjects used by Prof. Pillsbury in his experiments and the results compared with those which he had obtained. A very close correspondence between the two series appeared, but certain apparently anomalous results will require discussion, and reference to the earlier work will be necessary. It seems best, therefore, to begin with a brief summary of the conclusions which may be drawn from the results set forth in all three of these papers so far as they have any bearing on our present work.

Dr. Slaughter's conclusion from his experiments means that "the fluctuations of the attention are in close connection with at least three physiological rhythms." In the great majority

[1] *Am. Jour. of Psy.*, Vol. XII, 313.
[2] *Ibid.*, 335.
[3] *Am. Jour. of Psy.*, Vol. XIV, 277.

of cases they follow the Traube-Hering waves; in some subjects the respiratory rhythm predominates, while in a third class the important thing is a much longer rhythm which is seldom represented in the volume tracings. Since this third wave was found in but one subject, and as in our later experiments Traube-Hering waves of about the same length not infrequently appeared singly or in short series among waves of medium length, it seems needless to set it in a class by itself; and the important result reached is that the periods of fluctuation stand in close relation to the vaso-motor and respiratory processes. In explanation of this relation Slaughter suggested that the activities of the vaso-motor and respiration centres "in some may reinforce the functional activity of the sensory cells." This theory was suggested by the discovery that voluntary effort caused a marked increase in the efficiency of attention, as measured by the ratio of the period of visibility to that of invisibility, while the total wave was shortened; and by the fact that "respiration waves are found in blood pressure tracings and that both vaso-motor and respiration effects are found in the rate of the heart." In the latter the effect noted is probably to be explained by the overflow of impulses from one centre to another while in the former there seems to be a similar reinforcement of the sensory centres by irradiation from the motor centres. The shortening of the total attention wave as a result of voluntary effort will be discussed later.

Last year Bonser,[1] working independently and in ignorance of Slaughter's results, confirmed the parallelism between fluctuation of the attention and the respiratory and vaso-motor rhythms. In five of the seven records which he reproduces the attention waves follow the respiratory rhythm though the vaso-motor waves are quite distinct in the pulse tracings. In the other two the periods of visibility begin, as a general rule, shortly after vaso-constriction commences and continue well into the following vaso-dilation. Strangely enough Bonser makes no mention of the influence of respiration.

The object of Taylor's work was to "throw some light on the much disputed question as to whether the attention waves are of central or peripheral origin" by ascertaining the influence of certain sensory stimuli on the fluctuations. The minimal stimulus was obtained from a Masson disc and the fluctuation recorded by a Marey tambour on a horizontal drum. At each observation a normal record was taken and then a record with stimulation, usually by an induction current, though both pleasant and unpleasant olfactory stimuli were sometimes used. The fluctuations were measured and averaged and the length of

[1] Psychological Rev., Vol. X, pp. 120 ff.

the total wave as well as the attention efficiency under the influence of stimulation compared with the normal length and efficiency. Of the three subjects used the first gave a decrease of 3.6 sec. in the length of the total wave under unpleasant stimulation and an increase of .4 sec. under pleasant stimulation. The attention efficiency varied directly with the length of the total wave. With the second subject all stimuli, whether pleasant or unpleasant, increased the length of the wave an average of 1 sec. and heightened the efficiency. With the third subject the length of the total wave was uniformly increased but the efficiency was sometimes increased and sometimes the reverse. In the case of the first subject the respiration waves varied with the attention waves while in the other cases the breathing waves were shortened and the attention waves lengthened.

In the face of these apparently contradictory results we must agree with Taylor that each subject must be studied separately. The fact of wide individual variations is shown clearly. It seems perfectly plain that, so far as the effect of sensory stimulation on the length of the attention waves and an attention efficiency is concerned, every individual is a law unto himself. It is no less plain on the other hand, that in most cases stimulation causes a lengthening of the total wave and along with this an increase in efficiency. The problem involves the study of a set of functions which are easily disturbed by any kind of interference and which are bound up with plastic structures in which wide individual variations on the one hand and the establishment of fixed tendencies on the other are to be expected. Thus the impossibility of discovering rigid and narrow rules which are valid for all subjects is evident at the start; but it is possible to show the existence of general laws holding throughout the various types to which the particular cases may be reduced.

For further evidence of the necessity of this method we may turn to Prof. Pillsbury's work on attention waves and fatigue. In these experiments the fluctuations were recorded on the horizontal drum used by Taylor. Four records per day were taken from each subject with the exception of one man whose afternoon record was omitted. The records were taken at about 9:00 A. M., at noon, at about 2:00 P. M., and at 6 P. M. It was found that the length of the attention wave and the attention efficiency have a diurnal periodicity relatively constant for each individual while the curves of different individuals vary widely, and further that this curve indicated the type of worker to which the subject belonged. It appeared, also, that in every case "the greater length of wave corresponds to the time of greatest attention efficiency," which confirms the general con-

clusion we drew from Taylor's work. The fact that this relation held for all six of the subjects used, and through a series of experiments extending for most of them over a considerable period of time, is suggestive. In connection with the previous work the results would seem to point directly to the central origin and control of the fluctuations.

Summing up the work thus far we may conclude:

1. That in most subjects the attention waves stand in close relation to the Traube-Hering waves, while in a minority of cases there is an equally well defined coincidence with the respiratory rhythm.

2. That voluntary effort and sensory stimulation increase attention efficiency in nearly every case.

3. That in the majority of cases the periods of greatest efficiency coincide with the periods of greatest wave length while in a few cases the reverse is true.

4. That similar individual variations occur in the effect of fatigue and sensory stimulation on the length of the attention wave while this effect is constant for particular individuals.

5. That the fluctuations show for each subject a diurnal periodicity of efficiency and wave length peculiar to that subject.

In view of these conclusions the necessity of further work on the Traube-Hering waves is plain. If Slaughter's theory has any basis in fact we should expect that in the great majority of subjects the vaso-motor waves would be affected by voluntary effort, by sensory stimulation and by fatigue in precisely the way in which the attention waves are affected by the same influences. More exactly we would expect: (1) that voluntary effort would increase the length of the Traube-Hering waves in those subjects whose records show an increase of attention efficiency to correspond to an increase in the length of the total wave, and that the opposite effect would be produced in those subjects whose records show the reverse of this relation; (2) that sensory stimulations would have the same effect on the length of the Traube--Hering waves as on the length of the attention waves, *i. e.*, would increase it in nearly every case; (3) and that the Traube-Hering waves would show *for each subject* a "diurnal periodicity corresponding to that noted in *his* attention waves." A similar correlation of attention and respiration would be expected in those subjects in whom the breathing rhythm plays the predominant part in determining the fluctuations of attention.

Our experiments were begun with the purpose of determining whether or not these apparent relations can be shown to exist. One difficulty presented itself at the outset. No direct comparison of our results with those obtained by Slaughter and

Taylor was possible, since we were obliged to use different subjects, and while Taylor's subjects showed very wide individual differences, our own, as will be seen, presented far less distinct differences of type. It will be shown later, I think, that this difficulty is not so serious as it first seems. On the other hand a very close correlation of our results on the diurnal changes in the length of the Traube-Hering waves with those on the changes in the attention waves was possible, for the same men were used as subjects throughout. This is important, for it enables us to emphasize the fact of individual differences on the one hand and the close agreement of attention and vaso-motor or respiratory rhythms on the other, and on this basis to explain the apparent opposition between our results and those previously reached.

In our work upon the effect of stimulation on the length of the Traube-Hering waves the tracings were taken on the drum of an ordinary vertical kymograph. The pulse tracings were recorded by means of the delicate piston-recorder attached to the finger-plethysmograph or by the Hallion-Comte plethysmograph in connection with a Marey tambour. A pneumograph attached to a Marey tambour registered the changes in respiration and the time was recorded by a Jacquet chronograph. The pointers were set in a vertical line so that any disturbances in the respiration and pulse tracings could be carefully compared. The time required for a revolution of the drum was about five minutes and each record lasted through two revolutions. During the first an effort was made to eliminate every disturbance and secure a perfectly normal tracing; during the second the stimulus was applied. This stimulus was commonly an induction current passed through the free hand, but with three of the subjects pleasant and unpleasant gustatory and olfactory stimuli were sometimes substituted. The Traube-Hering waves were projected on a straight line and there measured. The averages were taken and the effect of stimulus on the length of the wave determined for each record, after which the whole series was averaged for each observer.

The experiments extended through the greater part of the year. Five subjects were used: Prof. Pillsbury (P), Dr. Wallin (W), Mr. Hayden (H), Mr. Freund (F) and the writer (G).

The results were remarkably uniform. The absolute length of the waves varied considerably for each subject from day to day, but the ratio of the average normal wave to the average wave taken with stimulus was very nearly constant. The following table gives the results in averages.

(The first column gives the subject's name; the second the total number of records taken; the third the average length of

TABLE I.

SUBJECT.	NO. OF REC'DS.	NORMAL.	STIMULUS.	S.—N.
P	27	9.4	11.5	2.1
W	9	10.0	12.4	2.4
H	32	9.6	10.8	1.2
F	14	9.9	12.5	2.6
G	26	10.1	12.5	2.4

the normal Traube-Hering waves for the entire series; the fourth the average length of the wave taken with stimulus; the fifth the average increase in length resulting from stimulation).

In 105 of the 108 records taken the stimulation caused a distinct lengthening of the waves. In two of the remaining three very weak olfactory stimuli were used and no change in the length of the wave resulted. The third record was taken as a curiosity. The subject had complained of headache and nausea before work was begun. Strong vaso-constriction, weak pulse, and slightly shortened Traube-Hering waves resulted from the stimulation with the induction current. In all the other cases the waves were lengthened, with total indifference to the pleasantness or unpleasantness of the stimulus. The effect of the pleasant and unpleasant olfactory and gustatory stimuli was precisely the same as that of the painful induction current. An abrupt change from a very pleasant to an unpleasant stimulus or *vice versa*, and even several such changes in the course of a single record, produced exactly the same result as the constant stimulus.

Assuming the validity of the conclusions reached by Slaughter and Taylor these are the results we should expect. Taylor's work showed that no general rule for the effect of stimuli on the length of the attention waves valid, for all subjects, can be reached, but that in most cases the wave length is increased and that efficiency generally varies directly with the wave length. Since, as Prof. Pillsbury found, increase in wave length and increase in efficiency do coincide in the case of the five subjects from whom our results were taken, the lengthening of the Traube-Hering waves by stimulation is what must have happened on the basis of the central theory; and Taylor's mixed case, so far from contradicting our results tends indirectly to confirm them.

It will be remembered that Slaughter found that voluntary effort increased the efficiency of attention but shortened the total wave. In the hope of securing further evidence for the central theory Mr. Sherman, who was then doing some work

involving the use of the ergograph, took several pulse tracings to determine the effect of effort on the Traube-Hering waves. The experiments were conducted in practically the same way as those in which the effect of sensory stimulation was being investigated. The observers were Mr. Sherman (S) and Mr. Hayden (H). The records were turned over to the writer and the averages are given in the following table.

TABLE II.

SUBJECT.	NO. OF REC'DS.	NORMAL.	VOLUNTARY EFFORT.	V. E.—N.
S	7	7.5	9.2	1.7
H	10	7.6	9.1	1.5

The effect of voluntary effort was, in each case, to increase the length of the vaso-motor waves which is directly opposed to Slaughter's results. On the other hand he found that the efficiency of attention was increased and in the case of our subjects' increase of efficiency coincides with increase of wave-length. Further there is no reason to suppose that voluntary effort any more than sensory stimulation must affect all persons alike, and it seems probable, as I hope to show, that the effects of effort and stimulation on the Traube-Hering waves must be identical. Finally, and most important, it was found in records previously taken that in both of these subjects voluntary effort increased the length of the attention waves.

It now becomes necessary to bring forward some physiological explanation of this change in the lengths of the vaso-motor waves. The fact that sensory stimulation and voluntary effort affect the vaso-motor waves, in most cases to lengthen them, seems quite beyond dispute, but how this effect is produced is not evident. It is generally supposed that the Traube-Hering waves are due to a periodic excitation of the vaso-motor centre by cyclic changes in the blood pressure at the medulla.[1] Anæmia of the medulla excites the centre and causes a constriction of the peripheral vessels and a consequent rise of the arterial pressure, at which the excitation ceases and the pressure is allowed to fall, anæmia of the medulla results and the round is repeated. The explanation is, however, complicated by the fact that vaso-dilation as well as vaso-constriction is, from the point of view of nervous physiology, an active process. The vaso-motor nerves contain both constrictor and dilator fibres, and a complete Traube-Hering wave involves the activity of both.[2] The fact that vaso-constriction rather than vaso-dilation

[1] Schäfer: Physiology, Vol. II, p. 139. [2] *Ibid.*, pp. 132-134.

follows an excitation of the vaso-motor centre is doubtless due to the fact that the latent period of the vaso-constrictor fibres is but little more than one-third as long as that of the vaso-dilation fibres.[1] It has been shown experimentally that "if the vaso-constrictors and dilators are stimulated simultaneously, the constrictor influence at first overpowers the dilator. The dilator effect, however, appears afterward, for the vaso-dilator fibres are less easily exhausted.[2] That is "the vaso-dilator effect appears after a longer latent period, while it reaches its maximum and disappears more slowly."[3] We would therefore expect to find the Traube-Hering waves in the pulse tracings divisible into a shorter descending section representing the period of vaso-constriction and a longer less steep ascending section representing the period of vaso-dilation. A careful examination of our plethysmographic records was made, and it was found that this relation between the two parts of the wave held for the averages of a large number of measurements, but where only a few waves were measured the reverse of this relation or an exaggeration of it was found. These irregularities were traceable to interference from the respiratory centre and from external stimulations.

The fact that many, if not all, external stimuli cause an initial fall in the volume curve is beyond question, and the only reasonable explanation of this seems to be that here is an irradiation from the sensory centres upon the vaso-motor centre causing immediate stimulation of the constrictor fibres. The overflow of impulses from a sensory to a motor centre is a well established fact of nerve physiology, so this explanation presents no difficulties of theory; and the equally well established fact of the overflow from one motor centre to another accounts for the effect of voluntary effort and demands that this effect be precisely the same as that of sensory stimulation. We would expect, then, on the basis of purely theoretical considerations that the effect of sensory stimulation or voluntary effort on the vaso-motor nerves would be somewhat as follows: There would be an overflow of impulses upon the vaso-motor centre causing increased excitation of both constrictor and dilator fibres. If the activities of the two were precisely alike no change in the volume-curve would take place; but owing to the shorter latent period and greater excitability of the constrictor fibres there would be an initial constriction and a hastening of the constrictor effect which would thus reach its maximum more quickly than under normal conditions, and this part of the wave would be shortened. Since, however, the

---

[1] Schäfer: Physiology, Vol. II, p. 135.
[2] *Ibid.*, p. 134.
[3] *Ibid.*, p. 135.

dilator effect reaches its maximum and disappears more slowly the decrease in the length of the constriction would be somewhat more than balanced by a proportional or more than proportional increase in the length of the dilation and the effect would be an increase in the length of the total wave. The constrictor effect would be hurried to its maximum and would disappear under the combined influences of exhaustion and the opposition of the increased dilator activity. Then, since the dilator fibres are less easily exhausted and have no further opposition, vaso-dilation would continue beyond the normal period, its maximum effect is increased and consequently the time required for its disappearance is greater than when no reinforcement was present. The relative change of length would probably be slightly greater in the period of constriction, but even if this were true the final result would be an increase in the length of the whole wave owing to the greater length of the normal dilation. Further examination of the pulse tracings showed that in spite of many irregularities and variations the increase in wave-length under stimulation was due to an increase in the length of the period of dilation while the length of the period of constriction was decreased. We were, of course, obliged to use averages, no direct comparison being possible. The general effect is well brought out in Table III taken from a somewhat exceptional record.

TABLE III.

N.	Nd.	Nc.	S.	Sd.	Sc.
10	6	4	11	8	3
7	4	3	12	8	4
12	7	5	9	7	2
10	7	3	11	6	5
10	6	4	11	9	2
10	6	4	11	6	[illegible]
[illegible]	5	3	14	10	4
9	[illegible]	3	8	6	2
[illegible]	5	3	11	9	2
12	7	5	12	9	3
7	4	3	10	8	2
11	[illegible]	5	10	8	2
9.5	5.7	3.8	10.8	7.8	3

(The column headed N gives the length of 12 successive waves from the middle of a normal tracing. The columns headed N d and N c give the periods of vaso-dilation and vaso-

constriction in each wave. The columns S, Sd and Sc give the same for the middle portion of the corresponding record taken with stimulation. The averages are at the bottom of the column. It will be seen that the lengthening of the waves averages 1.3 sec. The average increase in length of the dilation is 2.1 sec., while there is a decrease of the difference, .8 sec., in the length of the constriction.)

It now seems evident that any reinforcement of the medullary centres from the cortex, whether from sensory or motor activity, should produce an increase in the length of the Traube-Hering wave. In any case the source and character of the stimulus should make no difference in the effect. Against these conclusions, however, we have Slaughter's statement that voluntary effort produced a decrease in the length of the attention wave. Two explanations of this may be suggested, but an examination of his records and of pulse tracings from the subjects from whom his results were obtained, would be necessary to decide which is to be accepted. It is possible that the respiratory rhythm determined the fluctuations of attention in the cases in question and our records show that in nearly every case reinforcement of the medullary centres quickens respiration. It is also possible that in these subjects there was an unusually close balance between the activities of the constrictor and dilator waves. The records taken from H show a very close balance between the length of the constrictor and dilator periods, and reference to Table I shows that the increase of wave length caused by stimulation is only about one-half as great as in the other four cases. That in some individuals the opposite of the usual relation holds is uncertain but not impossible or even improbable.

We pass now to a consideration of the daily rhythm of the Traube-Hering waves. The apparatus was the same employed in the investigation of stimulus effects. Four records per day were taken at the hours on which Prof. Pillsbury had taken his records in the experiments described above. Each record lasted from five to ten minutes and showed from fourteen to sixty-two Traube-Hering waves. The subjects were those from whom the results of Table I were obtained and from whom Prof. Pillsbury's records had been taken. In the cases of all the subjects except F some months elapsed between the times when the records for the daily rhythm of the attention waves and those for the daily rhythm of the vaso-motor waves were taken. The comparison must, therefore, be of averages and a parallelism of tendency is all that can be expected. Where the attention waves of any subject show a uniform daily periodicity a corresponding periodicity should appear in the Traube-Hering waves, but the absolute lengths, even when the averages are

used, would almost certainly differ. The following tables give the results which are obtained and show the general correspondence expected. The attention measurements in the fourth column are copied from Prof. Pillsbury's tables in his articles on Attention Waves as a Means of Measuring Fatigue.[1]

[1] *Am. Jour. of Psy.*, Vol. XIV, 277.

TABLE IV.

P.

TIME.	NO.	T.-H.	ATT.
9.00 A. M.	106	10.0	9.6
Noon	88	9.2	8.5
2.00 P. M.	102	9.0	8.2
5.30 P. M.	124	8.6	7.5

TABLE V.

W.

TIME.	NO.	T.-H.	ATT.
9.00 A. M.	107	9.9	5.4
Noon.	116	10.4	6.3
2.00 P. M.	114	9.0	
5.30 P. M.	98	8.3	5.1

TABLE VI.

H.

TIME.	NO.	T.-H.	ATT.
9.00 A. M.	367	9.5	9.4
Noon.	316	8.4	8.6
2.00 P. M.	483	8.9	9.1
5.30 P. M.	252	8.0	8.4

TABLE VII.

F.

TIME.	NO.	T.-H.	ATT.
9.00 A. M.	80	9.4	18.9
Noon.	96	9.0	18.2
2.00 P. M.	87	6.3	13.4
5.30 P. M.	111	9.5	18.5

TABLE VIII.

G.

TIME.	NO.	T.-H.	ATT.
9.00 A. M.	174	8.8	8.9
Noon.	160	8.9	8.9
2.00 P. M.	203	8.4	8.4
5.30 P. M.	178	8.6	8.4

(The first column gives the time of day when the records were taken; the column headed No. gives the total number of waves measured; that headed T—H the average length of the Traube-Hering waves; and that headed Att., the corresponding measurements of the attention waves.)

In Table IV the general correspondence between the vaso-motor and attention rhythms is evident in spite of the greater length of the vaso-motor waves. In explanation of this difference in length it is enough to say that the records for the attention waves were taken in the middle of July while those for the Traube-Hering waves were taken in mid-winter and under very different conditions. Why the difference should be in this direction rather than the opposite it is impossible to say, but that there should be some difference was to be expected. What is significant for us here is the fact that there is a general decrease in the length of both the attention and the Traube-Hering waves from morning to night, a parallelism which can scarcely be accounted for save on the assumption of a common physiological basis.

In table V two interesting features are presented: (1) There is the evident correspondence between the attention and respiratory rhythms, shown by the very short attention waves; and (2) the fact that these waves show a definite daily periodicity which corresponds with that of the Traube-Hering waves. There is an increase in the length of both attention and Traube-Hering waves until noon and a decrease in the afternoon. This parallelism is readily explained by the fact that in the normal records the vaso-motor and respiratory activities seem always to vary in the same direction.

In Table VI the correspondence is much closer than in either of the two preceding cases. Not only are the absolute lengths nearly the same but the peculiar daily periodicity of the one is very accurately repeated in the other. Attention and vaso-motor waves show a decrease in length in the morning, a rapid recovery during the noon rest and again a marked decrease through the afternoon.

Table VII presents a new complication. The attention waves are about twice the length of those taken from the other subjects and almost exactly double the length of the Traube-Hering waves. As the two series were in this case taken within a few days of each other a fairly close correspondence of the absolute lengths would be expected. As for the two-to-one relation it seems probable that there is a summation effect at its basis, influenced also, perhaps, as the records suggest, by coincident reinforcement from the respiratory centre. But here, again, the important fact is that there is a very definite and constant relation between the two series indicating a common physiological basis.

In Table VIII the parellelism is so close that it may be allowed to pass without comment. The absolute lengths, as shown by the averages, are almost exactly the same for all four periods.

The significance of the results shown in these tables is unmistakable. The fact that the attention and Traube-Hering waves have the same daily variation is in direct line with Slaughter's conclusions and is one more bit of evidence that the two rhythms are causally related or at least have a common basis. Even if Slaughter's explanation of the relation between them is incorrect the relation itself would seem to be pretty thoroughly established.

It would seem to be of interest in the general controversy as to the effects of pleasantness and unpleasantness upon circulatory phenomenon, that all stimuli of any intensity have exactly the same influence upon the length of the Traube-Hering waves. Evidently here there is no trace of an opposed relation between pleasantness and unpleasantness.

Summary.

1. Traube-Hering waves are increased in length for each of five subjects by stimuli whether pleasant or unpleasant.
2. Muscular contraction, for two subjects, increased the length of the waves.
3. The daily variation in the length of vaso-motor waves is in the same direction as in the attention waves from the same subjects.

If we bring these results into connection with the effect of similar stimuli on attention waves, the argument would run, that Traube-Hering like attention waves are influenced by stimuli of all kinds, and that the universal direction of change for all our subjects was the same as for the majority of those whose attention waves have been studied. That there is great probability of individual variation, and that

subjects will be found for whom stimuli of suitable strength would quicken the rate of the Traube-Hering wave, is not unlikely. Only simultaneous records of attention and Traube-Hering waves can decide this point.

The similarity in the dirurnal variation and the close approximation in length of the two sorts of waves in three subjects, in spite of the different times at which the two investigations were carried on, make very strongly for the common physiological basis of the processes.

VIII. The Effects of Closing the Eyes upon the Fluctuations of the Attention.

By Bertha Killen.

Münsterberg's peripheral theory takes the stand that the fluctuations of the attention are due to the fatigue and recovery of the accommodation mechanisms in the sense organ. He made a number of elaborately varied experiments upon the sense of sight. His method of experimentation was to fixate the gray rings of the Masson disk and record the fluctuations in series upon a white kymograph drum by means of a tambour and pencil. The general average of the normal fluctuations was first established at 6.9 seconds. He then varied his experiments by use of a "*prismatische lorgnett*" by means of which the field of vision was moved slightly to the side, requiring a quick movement of the eyes in order to keep the fixation continuous. In case the prisms were held continuously before the eyes, no very great change in the fluctuations would appear. But when the glass was interposed at intervals of two seconds it was found that the fluctuations could be lengthened from 11 to 14 seconds. In the next series, a sound was made by an assistant, every second, which caused the subject to close the eyes quickly for a moment, making a scarcely noticeable break in the fixation. Under these circumstances a decrease to entire vanishing never took place. But when the disk was covered at intervals by a screen the fluctuations went on unhindered.

In view of the fact that Pace recently used these results as a proof of the peripheral or retinal origin of the attention waves, it seemed worth while to repeat them to test their accuracy. Münsterberg argues from these results that the momentary rest permitted the eyes to recover from fatigue.

The subjects were Miss Udell (U.), Miss Barnes (B.), and Mr. Wright (W.), all research students in psychology and were careful, experienced subjects.

The experiments were carried on from September to February, 1903-04. In the case of U. and B. a normal and a modified

record were taken once a week at the same hour; with W., a normal was taken once a week Tuesday or Thursday and a modified record each Tuesday and Thursday, at the same hour.

The manner of experiment was as follows:

The subject fixated a Masson disk which was revolved by an electric motor and showed one dark ring. The subject sat at a uniform distance of about four feet from the desk. To get constant illumination, the disk was placed in a dark room lighted by electricity. A key was pressed at the appearance and released at the disappearance of the ring by the subject's right hand. The make and break were registered electrically on a smoked drum which permits a record of about ten minutes in length to be made. The drum with its motor was placed in a room 100 feet away. The normal record requires no comment. The modified record was taken in the same way with the exception that the eyes were closed every second on the beat of the metronome.

For B. and U. there were 20 normal and 20 modified records each; for W., 20 normal and 40 modified records.

The results vary and differ with each subject. The following are the tables of results:

Average length of period of visibility:

	B.	U.	W.
Normal,	3.8 sec.	5.4	7.6
Closed Eyes,	4.6	5.6	7.

Average length of period of Invisibility:

	B.	U.	W.
Normal,	3.2	2.8	3.4
Closed Eyes,	4.2	2.4	3.2

Ratio of Invisibility to Visibility. Each record was divided into five parts.

						Ave.
B.						
Normal,	.93	1.07	.92	.71	.60	.85
Closed Eyes,	.82	.87	.85	.95	.104	.91
U.						
Normal,	.71	.47	.48	1.56	.51	.75
Closed Eyes,	.54	.46	.40	.46	.40	.45
W.						
Normal,	.36	.50	.54	.51	.57	.50
Closed Eyes,	.41	.35	.61	.54	.64	.50

In the case of B., closing the eyes once every second increased the wave of visibility .8 seconds and the period of invisibility one second. With U., the period of visibility was increased two seconds and the record of invisibility decreased .4 seconds. With W., neither the average visibility or invisibility show the increasing tendency. A study of the different stages in the record, however, shows there is a decided

increase in the third period and a slight increase in four and five, it is evident that the voluntary effort first inhibits, then reinforces the perceptive processes. These two influences happen just to cancel each other and the general average is the same for each.

In the case of B., closing the eyes increased the relative efficiency of the attention wave; with U. the effect was a decrease of the efficiency; for W., there was first a decrease then an increase in the efficiency. These individual differences can be explained consistently by the fact of individual differences. Taylor,[1] in his article on "The effect of Certain Stimuli Upon the Attention Wave" has shown that with the same person one stimulus may increase the efficiency of the attention while a stronger would decrease it. In these experiments the stimulus was uniform but would affect different subjects as stronger and weaker. To U., they seemed stronger than to the others.

With W., the proportion of black in the ring was increased until the fluctuations disappeared entirely during the latter part of the record in the closing eyes series. This was found when there was 1/50 part black in the ring. In the normal record the fluctuations still appeared as follows:

Wave of Invisibility 1.8 sec., Visibility 5.2 sec.

The disk used for the other records with W. had 1/75 part black; for U. and B., 1/92 part black.

It would seem, then, that Münsterberg's results are not valid for all people or for all intensities of stimulus or degrees of stimulus differences. What does happen is that there is for certain individuals, probably those of a phlegmatic temperament, a tendency for voluntary effort, as for any stimulus, to reinforce the sensory processes involved in seeing the gray ring, and it chanced that Münsterberg hit upon exactly that intensity of stimulus which could be made supra liminal by the reinforcement. We have beeen able to hit upon the same intensity for W. For B. we find the same tendency but the stimulus difference was too far below the limen to be made continuously supra liminal. For U., on the other hand, there is a tendency toward decrease of efficiency. It seems very much easier, then, to explain both Münsterberg's results and our own by the central reinforcing than by a peripheral theory.

Summary.

1. Closing the eyes for a moment at regular intervals increases the length of the attention waves and decreases the time of visibility.

2. The slight stimulus of closing the eyes has a tendency to increase the efficiency of the attention waves.

---

[1] *American Jour. of Psy.*, Vol. XII, p. 335.

THE TENDENCIES OF EXPERIMENTAL PSYCHOLOGY IN ITALY.[1]

Critical Note by Dr. GIOVANNI CHIABRA, Professor of Philosophy in the Academy of Lanciano (Chieti).

Here in Italy, where the interest in experimentation arose during the brightest period of the Renascence, chiefly with the great Galileo, the experimental study of mental phenomena is assiduously pursued. We have three laboratories of Experimental Psychology: one at Turin, in the Institute of Physiology, directed by Prof. Angelo Mosso; another at Rome, established and directed by the anthropologist, Prof. G. Sergi; a third at Florence in the Institute of Higher Studies (Professional and Training School), of which Prof. Francesco De Sarlo, the eminent psychologist and philosopher, now physician and surgeon in the royal army, is director. I am seizing this present opportunity to give a brief note on the actual state of Experimental Psychology in Italy; reserving for another paper the mention of other tendencies that have able representatives among us,—men like Senator Carlo Cantoni, recently appointed honorary professor in the University of Königsberg, in recognition of his eminence in Kantian studies; or the professors Fillipo Masci, Roberto Ardigò, Francesco Bonatelli, and others. The main purpose of this brief essay is to trace the two currents of psychological thought, now dominant in Italy, which, in a general way, correspond to the schools of Münsterberg[2] and Wundt.

---

[1] Translated by Mr. H. C. Stevens, Cornell University.

[2] H. Münsterberg, as is well known, starts out, as does the Wundtian School, from experimental psychophysiology; but he arrives at conclusions different from those of Wundt, in that he reduces all the complexity of mental life to sensations alone. Moreover, in his action theory (Aktionstheorie), he considers the impulse solely in the mechanical aspect of the reflex act, subordinating it, therefore, to physiological laws. In opposition to Wundt who admits the duplicity of causality, with respect to internal and external experience, Münsterberg maintains that psychical causality is not valid; that, for example, the ultimate problem of the psychology of the will consists in determining what excitations of cortical centres are necessary, in order that the sensations which arise in consequence combine in a way to constitute an act of will. But Münsterberg's theory is not founded on positive facts, nor is it sustained by physiology; it is, furthermore, too schematic, and it is contradictory to psychological experience.

I.

The representatives of the first tendency expressly postulate a complete correlation between mental organs and mental functions. Experimental Physiology, they say, has bridged the gulf between the two provinces of fact, although up to the present time it may have explored only a very limited field, in which there is much doubt and uncertainty. But the proof that can be given for other organs and functions is still lacking in the case of the brain and mental phenomena. It is true there have been some innovators in histology who believe that the solution of the psychological mystery is to be found in the cells stained by Golgi's method. In order to gain a vantage ground, they have called the pyramidal cell of the cerebral cortex, "psychical cell" or "cell of volition." They have asserted, further, that this cell synthetizes our conscious activity by expressing it in a voluntary act, for that reason acquiring the highest morphological differentiation. But serious criticism soon showed that they had reinstated an error of the old metaphysics, habited in modern garb. The hypothesis of a "cell of volition," of an "archicell," of a "pontifical cell" was of the same sort as that of the "seat of the soul." The soul, thanks to the advances of physiology, was always shifting from one seat to another: from the pineal gland, which is known to be an atrophied centre of vision, from the ventricles of the brain, from the centrum ovale, from the corpus callosum. So that, if the hypothesis of one seat were still tenable, the soul would have to be lodged in all the psychical centres, and even in the whole of the cerebrospinal nervous system. The same school declares that if it were true that physiological psychology presupposes the theory of a nerve motion, which has been named neurokyme, it must be admitted that the nature of this nerve motion is wrapped in profound obscurity; but that even if the physiology of the central nervous system had got beyond the tentative stage, and if the theory of neurokyme had been developed as far as the physics of vibrations, and if, further, mechanical formulæ had been derived, representing the masses, velocities and positions of all the cerebral elements of a given moment, still, one would merely know how the energy of the stimuli had been transformed into an organic molecular motion by means of the potential energy accumulated in various organs of the nervous system; but in this physical process there would still be no trace of a mental process. Accordingly, several authors concern themselves with the mode of behavior of the nerve cell and of the cells of the sense organ under different conditions of activity and repose. It seems, moreover, that marked changes, in both the nucleus and protoplasm, have been

brought to light. There are, too, some workers who attempt to demonstrate minute changes in the cells, in different pathological conditions of the nervous system. But all of these studies offer only promises, beneath which one seems to hear the whisper of something like the hope which always flourishes where science flourishes,—though in reality the attempt is fallacious—the hope of founding all the phenomena of life on these chemical and physical phenomena, of pervading physiology through and through with chemistry and physics. In the actual state of the science, the features common both to the nervous system and to consciousness are enumerated by Höffding.[1] 1. The nervous system serves as the central organ of co-ordination for the different parts of the organism; consciousness unites what is separate in space and time. 2. Change and process are alike conditions for the functioning of the nervous system and for the activity of consciousness. 3. The stimulus does not excite one centre only; but by means of the manifold branchings of the nervous system, it evokes a series of excitations in centres connected with that first affected. In the same way, the effect of a sensation is extremely complex, since it has the power to recall a great number of ideas. 4. The reaction time, or physiological time, stands in direct proportion to the complexity of the mental operations. 5. Corresponding to the opposition between the active and passive aspects of thought, there are the sense organs and afferent nerves on the one hand, and the nerve centres and efferent nerves on the other. But except for these conclusions, showing the attempts of those who would make psychology "the physics of human thought," no physiologist on the basis of all the wonderful advances of his science would be able to deny that there is a gulf between the molecular state of the brain corresponding to a thought and the thought itself. Supposing for a moment, at least, that physiological psychology had achieved such progress as to be able to express with mathematical precision, the velocity, direction, composition and reaction of molecular motions, for every volition, emotion and thought, still, however much faith one has in science, the physiological series, for thought, would simply be a system of signs analogous to those of language. Unless, indeed, by starting out from an *a priori* proposition, with the method that has been so much condemned in Scholasticism, our psychologists mean to deduce a *speculative* doctrine of the relations between the matter of the brain and the manifold manifestations of the mental life, not content with the pure and simple conclusion to which all the analyses and all the research of contemporary science have come. At the same time, apart from

[1] Psychology, pp. 62-66.

this prejudice which tends to reduce the spiritual entity to a mechanical law, as though man were no more than a mass of muscles and nerves, irrigated by blood, important researches have been accomplished in this field of psychology which with strictness of terms may be called physiological psychology. Angelo Mosso, especially, may be mentioned in this connection as a profound observer and investigator. Playing upon the human organism, by his varied physiological appliances, as a musician plays upon his instrument, he seeks to determine by experimental means the organic states and functions which underlie and explain the psychical phenomena revealed to his introspective intuition.

II.

De Sarlo[1] is the representative of the second tendency. He admits that Psychology as a positive science must be taught by the method of positive sciences. A science of fact, he says, can be taught only by means of the demonstration of these facts; and the means of demonstration are observation and experiment. To teach psychology to-day, without some means of demonstration, would be as absurd as on the other hand to found a laboratory of philosophy. And a laboratory of psychology, thanks to De Sarlo's own energetic initiative and to the co-operation of Pasquale Villari and of Felice Eocco, has been recently established in the Royal Institute of Higher Studies.

We hope that a similar change will be made presently, in the other philosophical faculties of the kingdom.

Now the direction which De Sarlo is trying to give to the study of psychology is new, original and, in my opinion, right; it deserves, therefore, a brief note.

Before all, De Sarlo believes that there can be no psychology which is not animated by the principle that "a real subject exists." It is not the business of the psychologist to examine the nature of such a subject, much less, to find a place for it in the system of cognitions, by proceeding from philosophical premises. It belongs to philosophy, and, properly speaking, to epistemology (in this point, he agrees with Wundt and Titchener), to criticise this concept, which may even be false but which is, nevertheless, indispensable to psychology, just as certain prin-

[1]*Cf.* especially, the following parts of the works of De Sarlo. 1. *Experimental Psychology in Germany*, the most important paper, which was published in the Rivista Sperimentale di Freniatria, Vol. XIX, fasc. I; 2. *The Object of Physiological Psychology*, in the Essays in Philosophy, published by Clausen in Turin in 1896; 3. *The Concept of Mind in Contemporary Psychology*, read March 1, 1900, before the Royal Institute of Higher Studies of Florence; published by E. Ducci, Florence; 4. *The Data of Mental Experience*, the latest publication of the Royal Institute of Higher Studies.

ciples are necessary to many other sciences, the atom to chemistry, motion to mechanics, etc., and without them analysis could not be made. An organism can come only from an organism; and, furthermore, even in physiological life, there is something that cannot be reduced to chemical and mechanical principles alone. The evolution of the germ cell shows how an organism requires the postulate of *life* in order to be understood from the physiological point of view: notwithstanding the fact that this postulate is excluded from modern science, on the ground that it would be a vital force detached from the organism. Similarly the concept of mind, understood as a real and active subject, is the postulate of every psychological discussion. It stands for the content of mental life, which has its own principle in itself, in so far as it is something spontaneous and individual. The germ cell is not merely a chemical compound, but it is the potentiality of life; this law holds as much for psychology as for biology. As in the circumference of a circle, every arc exemplifies the law and necessarily presupposes it, so every phenomenon of consciousness, in order to be understood, must be referred to the individual subject of which it is only an expression.[1]

But what is Psychology according to De Sarlo? He gives the following definition of it. "It is that science which has for its object the study of the arousal and course of that particular category of facts or processes which is called psychical." This category is chiefly distinguished from all others by its character of incommunicability. The mental facts are individual; they cannot be transferred to another person. They are something more than that: but when they are studied from the psychological standpoint, they must be considered in abstraction from all the rest of reality, as necessarily referring to an empirical subject,—not the subject with which epistemology has to do, but an organic individual who occupies a determinate position in space and time. It is true that we communicate our thoughts, our ideas and our feelings, etc.,—but we do not communicate directly: rather indirectly, by means of written and spoken words and gestures. "It is impossible to read directly the consciousness of another individual and to feel precisely as he feels at any given moment." At this point, one may raise the question whether this method of viewing the facts of mind, according to De Sarlo, is right. We believe that it is, and we will briefly give our reasons. In order to express our ideas, we are constrained to make use of words; our thought thus assumes a spatial form. That is, the spatial

[1] *Cf.* the admirable lecture, *The Concept of Mind in Contemporary Psychology*, delivered before the Institute of Higher Studies. Florence, 1900, B. Ducci.

distinctions which language forces us to impose on ideas are as sharp and precise as those we impose on physical objects. Now this tendency of ours, to translate non spatial phenomena into spatial terms, thus mutation of quality into quantity, is the cause of all the perplexities arising from certain psychological problems. Indeed, if there exists a contradiction in the formulation of the problem, it is natural that a contradiction, likewise, should be found in the solution. In fact, in the superficial stratum of consciousness which reflects the images of the external world, the phenomena preserve that discreteness, that isolation, which characterizes their objective correspondents (it is precisely to the simple sensation that the theory of association adapts itself); but in the deeper lying strata, the states of consciousness depend upon and receive their color from all the other states, and therefore every individual loves and hates in his own way, thus revealing his whole personality. Language, overlooking this difference, uses the same word for all individuals. It results, therefore, that only the impersonal elements of emotions are expressed in language. We cannot translate our impressions into words. Language is inadequate to thought. But, as a matter of fact, mental phenomena are not fixed; they vary continually; and, if it seems that they do not change, it is because we do not attend to them, but to their external causes, or, rather, to the names of the objects. Language predisposes us to errors of judgment in the matter of sensations. For example, any one eating a piece of meat which is considered a dainty can be induced to believe that it appears so to him, although it does not. In sum, the word merely expresses what is common to states of consciousness, without taking account of subjective variations. Our emotions, especially, are phenomena that change continually and in which every element receives its color from the combination in which it happens to be. When we analyze an emotion we destroy that which constituted its real and concrete individuality. We have no more than the shadows of ourselves. So that instead of having decomposed into its true components the emotion we set out to analyze, we have split it up into hard impersonal elements to which we give a name and profess to be able to apply logical laws. Thus, consciousness presents a different aspect, according as it is regarded in itself or spatially; just because the fundamental phenomena of mind are qualities that so intermingle that it is impossible to distinguish them or even to ask whether they are one or many. Mental phenomena have a manifold duration which is, as Bergeon would rightly say, a qualitative not a quantitative duration.

Now, if one accepts De Sarlo's way of stating the psychological problem, one avoids all confusion between space and

time, between simultaneity and succession, between quantity and quality. A sensation, a perception, an image, a word thought or even pronounced, a feeling, an impulse, present themselves as facts that have the characteristic of being qualitatively different and irreducible one to another. The connections which we predicate of them are different from and irreducible to one another; the connections, for example, which we posit between a sensation and a feeling are founded solely on experience, on the habit of seeing a sensation associated with a feeling, etc. The field of psychology is thus clearly limited. One may say that it embraces all that we know in the world of qualitative difference. Having defined psychology thus, it would seem that De Sarlo must accept, without change, the opinion of Wundt that psychology has the same subject matter as that of the natural sciences: since, if psychology studies the mental qualities and if all that we know in the world is represented by all these qualitative states, we ought to say that the psychological point of view is co-extensive with the whole realm of reality; thus psychology and the natural sciences would have the same reality as an object, but each would regard it from a different point of view. But, according to De Sarlo, the difference between psychology and the other natural sciences is very much greater than that stated by Wundt, Höffding and Masci. Psychology studies the origin of the various qualities in consciousness, but it does not consider them as constituting external reality; it distinguishes between objects that are conceived to be outside of consciousness, and the qualitative states themselves, that arise in consciousness. By proposing to study mental facts, we are forced to say that there are external objects which, by acting on consciousness, arouse qualitative states; but we do not mean by this, says De Sarlo, to identify mental facts with external reality. That may be demonstrated in epistemology; but from the psychological point of view we are constrained to make a sharp distinction between states of consciousness and external reality, to set the world of mind over against the external world of reality. Progress in psychology is impossible without presupposing some facts outside of consciousness. These external facts are conceived by modern science as simple quantitative variations; all phenomena are reduced to mechanical laws. One may say that every advance in physics means the possibility of reducing a determinate group of phenomena, previously irreducible, to phenomena of mechanics; the vaunted unity of the physical forces consists just in the reduction of every form of energy to particular kinds of motions. Now, De Sarlo points out that when one speaks of quantity, one means a quantity of a given quality; that these qualities for physics are atoms and motion;

but that, inasmuch as quality is uniform through all phenomena, therefore, objectively, it loses its value and the essential matter comes to be the quantitative variations. The psychological problem arises out of the need of explaining the production of mental phenomena, having given the two elements, external reality and the active subject. The task of psychology, therefore, is to see how those qualities are produced, with which we invest the external world; and, especially, the study other mental phenomena (images, memories, etc.) which we do not attribute to external reality. It is not necessary, in fact, that qualitative states should be produced by physiological conditions, in the way that sensation presupposes the action of external stimuli. In that case, we have the external stimulus that arouses the sensation; then this sensation, in turn, is a stimulus that sets up mental facts of a higher order. Just as the ovum, after it is fertilized, at first appears a homogeneous mass of cells which, at length, become differentiated into folds and layers, from which tissues, organs and systems are developed, so the mental life of sensations evolves into still more complex mental qualities. In consciousness, therefore, we see different qualities; we may say, then, that the function of consciousness is to qualify, to translate into quality, that which is presented to it. For example, a visual sensation, given under certain circumstances, forms complexes with muscular and articular sensations, thus arousing other qualities which we interpret as objective, spatial determinations, that is, as something that is not given immediately to consciousness, but, on the contrary, is already outside of consciousness. Now, one who is not acquainted with psychology thinks that the eye immediately perceives spatial relations. Psychology, however, shows that this belief is erroneous. The eyes merely convey to consciousness the local signs, sensory qualities, which have a character of their own, by which they set up complex qualities of a higher order. Therefore, psychology, as a science, comprehends a system of laws which represent the connection between determinate conditions and the arousal of qualitative states.

After making the distinction between psychology and the natural sciences, De Sarlo holds a course remote both from the old metaphysic and from naturalism. He insists that psychical causality is a causality *sui generis;* not merely irreducible to, but totally different from, the causality of natural phenomena.

Psychology, according to De Sarlo, is an abbreviated expression standing for a group of special psychological sciences, which have special characters and which are subject to the limitation of point of view and method in the light of which, and by which, the mental phenomena are studied. The chief psycho-

logical sciences are the following: a. physiological psychology; b. experimental psychology, properly called psychophysics; c. empirical psychology; d. philosophical psychology. Physiological psychology has the following main tasks. First of all, it has to show in what way the relation between the external world and consciousness is established; in other words, it studies the structure and function of the sense organs. It has, further, to show in what way the phenomenon called motion produces effects in our consciousness and how it is that motions and vibrations of the ether are transformed into excitations of nerves, before reaching the central nervous system. It studies especially the general conditions of the activity of the nervous system, in order to show why changes in consciousness are co-ordinated with changes in the body. The nervous system is related to consciousness; therefore, to examine respiratory, chemical and metabolic relations, is to study the activity of the nervous system in relation to mental activity. We have, thus, a method for studying many important mental phenomena, as sleep, waking, health, fatigue, etc. Another problem for physiological psychology is the study of the bodily effects of mental phenomena. For example, we know that emotions have physical effects which, by acting as stimuli, may give rise to new mental facts. The emotion and the bodily response thus constitute a complete circuit which physiological psychology must resolve into its elements. Finally, since we know that the nervous system and mental activity stand in a relation of concomitance, we ought, therefore, to have a chemical physiology, by which to study the cerebral localization thus given. But with this, the problems of physiological psychology, according to De Sarlo, come to an end. As a result we stand merely in the court of the temple. Whoever wishes to know the human mind must consider physiological psychology as an introduction to it. It requires special study of certain parts of physiology (physiology of the nervous system, sense organs and their connections) and it makes use of such methods only as are used in the physiological laboratory. From what has been said, the importance of the mode of envisaging psychology, according to De Sarlo, is evident. Physiological psychology does not investigate mental facts; it studies merely the concomitants and antecedents of the physical facts relatively to the mental phenomena. At the same time, De Sarlo does not make a distinction between psychology, properly called, and physiological psychology, in the sense that to the former alone belongs the interpretation of conscious experience and to the latter the derivation of the same experience from physiological processes. De Sarlo rejects such distinctions as inconsistent. There is only one method of causal psychologi-

cal explanation, and that consists in a derivation of the more complex mental processes from the more simple processes. Understood in this way, the physiological elements can always come in, by virtue of the above mentioned relation between natural experience and psychological experience, but they are always subsidiary. Materialistic psychology, in denying the existence of psychical causality, has, in place of the task set by De Sarlo, the other task of deriving psychical processes from the physiology of the brain, thus occupying a position which, as was said, is indefensible both theoretically and psychologically.

The problems of experimental psychology, according to De Sarlo, are the following. 1. To study the formation of complex perceptions, by analyzing the images and sensations that compose them; and by showing how the elements go together. 2. To investigate the time required for certain mental facts and to show how they are related to the rest of consciousness (psychometry). 3. To determine the changes of mental phenomena in relation to stimuli; also to determine the dependence of intensity of mental facts upon the intensity of stimuli (psychophysics). In all of these researches, the laboratory of experimental psychology, such as was recently established in the Institute of Higher Studies of Florence, will be indispensable. De Sarlo, who was heart and soul the sponsor of this modern foundation, has gathered about him a good number of younger students[1] who, while pursuing various interests in philosophy, under the guidance of their teacher, enable Italy to make its contribution to the progress of experimental psychology.

We congratulate them sincerely upon this opportunity: because if there is, indeed, a line of division between the old psychology and the new, represented by the work of the German philosopher and psychologist, Herbart; if the founders of modern psychology were Weber, Fechner, Lotze, Helmholtz and Wundt; and if, from 1879 to the present, laboratories of psychology have spread and multiplied in Germany, England, France and America; Italy cannot and must not lag too far behind the other nations. In the historical development of the various

---

[1] De Sarlo has held a course of lectures on auditory sensations, supplementing the instruction by experiments. The results of the researches, undertaken in the laboratory, will be published in the appropriate journals. The titles are: *Automatic Movements and Mind-reading: Memory; The Perception of Time; Emotive Antagonism; Optical Illusions; Involuntary Movements in Connection with Pleasant and Unpleasant Sensations; Elementary Æsthetic Feelings; Affective Memory; A Study of Dreams; Attention and Physiological Phenomena.*

methods of scientific investigation, and especially of the experimental method, Italy too, has, glorious traditions!

Physiological psychology and experimental psychology may be considered, says De Sarlo, as two chapters of empirical psychology. In fact, in a general sense, empirical psychology embraces the study of the whole of mind, without the limitations of the two sciences just mentioned. But it has well marked characteristics which distinguish it from rational or speculative psychology. Rational psychology attempts to deduce the whole of mental life from determinate principles. Empirical psychology arises out of the need for a science of mind, the facts of which shall be arrived at, not deductively, but by means of introspection. Empirical psychology, thus, has the task, especially, of analyzing mental facts, of describing and making clear their composition and relations, by means of internal observation or introspection, and by taking account of suggestions that come from other sciences, as from psychiatry, which, dealing as it does with the complex phenomena in their disaggregation, presents an analysis naturally produced. Psychological explanation, says De Sarlo, is not identical with the explanation of natural science. Empirical psychology can establish connections between mental phenomena without knowing the ground for the connection: we can have psychological laws in the sense that we are able to follow out empirical co-existences and sequences in the qualitative states; but we are not able to study the formation of these states.

A necessary complement to empirical psychology is a metaphysics of mind, in the same way as there is a metaphysics of nature. Introspection reveals to us merely a succession of qualities; but when we wish to trace out the mechanism by which mental evolution is accomplished, we must refer to the purposes which consciousness reunites. The two edifices which the human consciousness must construct are knowledge and morality. We may say, therefore, that mental development is possible, in so far as it is directed toward the attainment of these two high ends. The metaphysics of mind cannot treat the human consciousness merely as one thing among other things, but rather as a microcosm; because, in exercising the two functions of knowledge and morality, it reflects in itself the whole universe. Considered from this standpoint, the science of mind is essentially philosophical.

A SKETCH OF THE HISTORY OF REFLEX ACTION IN THE LATTER HALF OF THE NINETEENTH CENTURY.[1]

By ROBERT H. GAULT, Late Fellow in Clark University.

TABLE OF CONTENTS.

I. Statement of the Theory and Extent of Knowledge at the Time of the Pflüger-Lotze Discussion. (1853.)
II. Inhibition of Reflexes.
III. Phenomena of Summation.
IV. Vascular Tonus.
V. Muscular Tonus.
VI. Tendon Reflexes.
VII. Direction of Transmission and Co-ordination of Reflexes.
VIII. Speculative Considerations.

I

A STATEMENT OF THE THEORY AND OF THE EXTENT OF KNOWLEDGE WITH REGARD TO REFLEXES AT THE TIME OF THE LOTZE-PFLUGER DISCUSSION (1853.)

Before making in greater detail the statement which is the subject of this section it seems well, in order to bring the reader into touch with the development of knowledge of reflexes previous to 1853, to give in brief form a running account of the comprehensive article by Doctors G. S. Hall and C. F. Hodge in the *American Journal of Psychology*, Vol. III. These papers present a sketch of the history of Reflex Action from the earliest studies thereof to the time when Lotze made his famous reply to Pflüger and formulated the theory of reflexes which bears his name.

It is there shown how, at first, the soul was supposed to be able, without the mediation of any bodily mechanism whatever, to create sympathy between different parts of the body. The type of mind of the early physiologists was theoretical rather than scientific. Indeed, so long as those early investigators were explaining bodily functions of every character by reference to an immaterial soul inhabiting the natural channels of the body, and acting directly upon matter according to its

[1] The writer wishes to express his obligation to Dr. E. C. Sanford, on whose suggestion this work was undertaken and by whose counsel it was carried to completion.

own freedom, no scientific physiology was possible. But as time advanced new phenomena were discovered which could not be classified under existing theories, and the new hypotheses to which they gave rise only increased the confusion.

Harvey discovered in 1628 that the arteries and veins during life are filled with flowing blood. The supposition that these channels, empty after death, were during life the avenues for animal spirits had to be abandoned; and Robert Whytt advanced the matter to a new stage by his explanation of the phenomena of life by the "power or influence of the nerves." The current was setting toward the Newtonian ideal, the maintenance of steadfast communication with facts.

Very early it had been found that some nerves when stimulated mediate sensation, others motion. It was left, however, for Charles Bell to show, and for Magendie more conclusively to demonstrate, that the posterior spinal roots are sensory, and the anterior motor. The way was then opened for further classification of phenomena. The anatomical elements concerned in reflex action, viz.: a centripetal and a centrifugal nerve with their part of the spinal cord, were known, and the next question was, "do these parts operate on mechancal principles or not?"

The first reply to this great question was in the affimative. Marshall Hall (1837) first proposed a mechanical theory of reflex action. He assumed a special excito-motor system in the cord and said: "There is nothing whatever that can be called psychic about any of its activities." He was enthusiastically supported by his German translator, Kürschner, who said that the activity of ganglia incites motion "as water drives a mill." Volkmann (1838), on the other hand, declares that in the lower animals, at least, it is certain that the sensitive principle is divisible; that, therefore, whenever the central nervous system be divided a portion of this principle remains on both sides of the section. Such animals cannot then be pure mechanisms as Marshall Hall had supposed. Volkmann, however, is not sure that this principle is valid for the higher animals.

Pflüger was bolder. Following in the footsteps of Volkmann, he violently asserts that consciousness (which he regarded as a form of motion) is, whether we call it "Sensorium" or "Soul," capable of division with the body. The spinal cord, then, has its soul; every portion of the body which, independently, is capable of responding to a stimulus, possesses a soul. "Reflex action is the operation of a neurophysic mechanism by means of which the sensory fibre through the cord, changes the ordinary state of excitation of definite motor nerves."

This brings us to Hermann Lotze and to the beginning of that period which furnishes the material for the following sections. In the Lotzean theory the soul has nothing to do directly in the production of reflex actions. Under certain limitations the theory may be described as mechanical; but all movement, whether of the intact animal or the reflex preparation, is proximately or remotely subject to the psychical. The starting point of all movement is in the soul. "If we call to mind, consequently, that activities earlier performed in consciousness have left behind not only unconscious memories in the soul, but also physical impressions in the central parts of the nervous system, we can consider purposive and adaptive movements to be dependent upon these impressions as well as upon a soul still in existence. For even the soul itself in the production of these movements should be considered not as an intelligent substance but as a substance with enduring states standing in reciprocal relation with one another and reproducing one another."

"The origin of certain movements of beheaded animals we seek not in an intelligence yet living, but in one which exists only in its after-effects. We believe that an animal body whose soul has had no experiences, or which has not worked out some experience into a life of ideas, would not be in a condition to perform those movements after the excision of its brain; we consider it not as a mechanism of the first construction, but as one of practice. When, under the influence of the soul life an association has once been formed between the mere physical impression of a stimulus and a movement which is not united with that stimulus by the mere relation of structure and function, and when that association has been firmly established, this mechanism can continue the activity without requiring the actual assistance of intelligence."

"In animal bodies examples of such habituation in function to which the influence of mental life does not extend are by no means wanting. Yet, much more frequently, we find them in the sphere of movements. Not only are almost all reflex movements produced the more easily and by slighter stimuli the more frequently they occur, but even the voluntary movements through practice become graceful and manageable. Many gestures, originally arising by chance, have gradually become customary, and we find them firmly and ineradicably rooted; finally the acquired mien, movement, and grace of the body is frequently transferred from generation to generation, which could hardly occur if the repeated function were not fixed in a remaining disposition of the central organs, and hence, were not capable of transplantation. As stature has placed at the disposal of the soul a principality of automatic

implements, the activity of the mind reacts upon it, giving it dignity, and the body is impregnated by the attainment of an intelligence which, nevertheless, is not identical with it, is not diffused through it, and at the same time is not separable from it."[1]

According to this theory the movements of the eel's tail away from the flame, and the purposive movements of the decapitated frog, cited by Pflüger as indications of a spinal soul, are not due to the presence of a soul in the cord, but to the after-effects of conscious activity impressed upon a plastic organization and transmitted by heredity. Lotze had, therefore, caught the idea of development from the conscious to the unconscious; the voluntary to the involuntary; from the spontaneous to the reflex; and we shall hope to see in the succeeding sections how this theory has stood the test of fifty years.

We shall now turn to a brief examination of the state of experimental knowledge of the physiology of reflex action at the time in question.

Among the most numerous observations are those by Pflüger, and since they suggested so many lines of research for the investigators who were to follow, his experiments are of great importance. He believed that reflex actions are best studied in men, especially in human pathological cases, and on the results of such studies he based his five laws of reflex action: the law of Unilateral Reflexes; of Reflex Symmetry; of Unequal Contraction on the Two Sides; of Reflex Irradiation; of the three Locations of Reflex Contraction. These laws were illustrated by many experiments on frogs, eels, and salamanders, and from these he concludes that sensory and motor nerves end in their respective levels of the cord, not in the brain which many regarded as the only organ of sensation and volition. As might be expected from a study of the Lotzean theory, its author declares that Pflüger's crucial experiments are too uncertain to warrant the inferences drawn from them.

It seems measurably correct to visualize the course of the studies of reflex action preceding the Lotze-Pflüger discussion as lying along the main trunk line of "physical" reflexes as they were then called; *i. e.*, bodily movements of defense against attacking stimuli. Nevertheless there had been some minor observations of the movements of the internal organs which were called "organic" reflexes, and which opened the way for later thorough investigations made possible by the discovery of improved devices for experimental observation, and improved methods of operation.

What has now become an almost impenetrable jungle of

[1] Lotze: Gelehrte Anzeiger, Göttingen, 1853, III, pp. 1737 ff.

literature on the inhibition of reflex action sprang from seeds sown by Marshall Hall, though the phenomenon was not subjected to detailed examination until a quarter of a century had passed. The observation made by Hall is now a commonplace with every amateur experimenter with reflex actions, viz.: that reflex movements cannot be produced in the first moment after decapitation. Whether this is due only to the shock to the central nervous system, as is now very generally believed, or to stimuli from the cut surfaces, is left for future determination. A typical instance of the restraining influence of nervous centres upon a particular bodily organ is the inhibitory effect of the vagus upon the heart. This was discovered by the Webers in 1844,[1] and almost forty years later McKendrick called it the "most recent advance in *nervous physiology*."[2] Our present knowledge of inhibitory phenomena, in detail, was, however, in 1853, scarcely begun.

Physiologists were not introduced to the summation of stimuli until the year following the discussion between Lotze and Pflüger, when Eduard Weber computed the rate of transmission in sensory nerves; and no really systematic work was done on the subject until nearly a score of years later.

Neither had the knowledge of vascular tonus made much further progress than that of inhibition, though Legallois, as early as 1830 or before, had observed that the circulation of the blood ceases much more quickly than otherwise if the spinal cord be destroyed after decapitation. And changes in the lumen of blood vessels had been observed from time to time. Indeed, it may be doubted whether, within the period of which we are now writing, at any rate until its very close, the tonicity of the vascular system was ever regarded as reflex. We have such eminent authority as J. Lister and Gruenhagen to support the statement that a notion of the reflex nature of the tonus of the vascular system begins with Claude Bernard in 1852 and Augustus Waller in 1853. For Bernard in the year named had shown that if the sympathetic nerve in the neck of a cat be severed the blood vessels on the wounded side become turgid, and the temperature of the parts is heightened. Waller, in the year following, completed the demonstration by showing that if the nerve above the point of section be stimulated by an electric shock, turgescence ceases and temperature subsides.

This bit of experimental knowledge forms an indispensable nucleus about which later scientists have built a vastly complicated structure. The cause of a reflex muscular tonus, on the other hand, is within this period much less clearly conceived.

---

[1] Artikel—Muskelbewegungen—Wagner's Handwörterbuch d. Phys. Bd., III, Abth 2 p. 47, 1844.

[2] McKendrick: A Lecture on Physiological Discovery. *Brit. Med. Jour.*, 1883, I, p. 708.

The term "tonus" was first used by J. Müller[1] to describe the tense condition of muscles in a state of rest, and Henle assumed that it is to this slight tension of the muscles of the face that we owe our natural facial expression. This tension was supposed to be dependent upon the constant influence of the central nervous system, and Hall and Volkmann shared the view. Although Ed. Weber, in 1844, revolted against the theory of such a muscular tonicity, it was the prevailing view held at the end of the period covered by the present chapter, and the strong reaction against it led by Auerbach and Heidenhain, distinctly marks the beginning of the following period of the study of muscular phenomena.

The tendon reflexes did not attract the attention of physiologists until nearly a quarter of a century after the beginning of the period we are reviewing.

If we except, then, the discovery of the inhibitory effect of the vagus upon the heart by the Webers, we see that the chief results obtained previous to 1853 were in the field of the bodily or limb reflexes which led to the formulation of Pflüger's laws. Thereafter, as a result of more delicate means of observation, increasing attention was given to the uniform and varied movements of the vital organs. The notion of the reflex character of organic behavior steadily encroached upon the field of the unknown. The reflex arc took the place of many a supposed spontaneous activity, and investigators since that time have gradually left the highways of philosophy for the intricate byways of physiological experiment. They have become more interested in the collection of facts than in their correlation; and more and more dominated by a desire for "pure" science. This is very likely the spirit in which all great achievements have been won, but it is likewise the spirit which leads to the production of a mountain of details, inexhaustibly rich in definite suggestions to other investigators and bewildering to those who attempt to set them in order.

So few within this period are the generalizations and discoveries of general importance to the comprehension of reflex action that it is difficult to make clear cross sections of the whole and to treat all between in a single chapter. We may, with considerable justification, consider the beginning of our fifty years as the point in the main current of our knowledge of reflexes where the stream breaks up into many parallel branches.

We shall, therefore, for the sake of convenience, treat these separately in their physiological groupings.

[1] J. Müller: Handbuch d. Physiol., 1837, Bd. II, p. 29.

II.

The Inhibition of Reflexes.

The problem of reflex inhibition is everywhere veiled in uncertainty. Consensus of opinion on this subject seems like a "Will o' the Wisp;" now almost at hand, the next moment far out of reach. And to-day our knowledge of the matter is hardly in a more settled state than it was a score and more of years ago.

This uncertainty is due, doubtless, to the difficulties that lie in the way of experimentation. Goltz, for instance, has shown[1] that after an operation has been performed, and the wound has healed, we have to deal with the vicarious functions of other parts. Hence we can never tell just what are the inhibitory functions of the injured part. Luciani has also called attention to the fact that we can never be sure how soon after the operation degenerations have begun in the cord nor how rapidly they have extended.

Following the discovery by the Webers of the influence of the vagus upon the heart, physiologists turned their attention especially to the function of this nerve. Schiff and Moleschott erroneously concluded from numerous experiments that it is motor to the heart. Pflüger, however, in his characteristically vigorous, not to say pugnacious, way demonstrated beyond a doubt that the heart is inhibited by the vagus nerve.[2] If the simplest rules of experimental practice in the application of electrical stimuli be employed, *i. e.*, if the vagus be isolated, no motor effect is discernible. On the contrary, as he says by way of conclusion: "The stimulation that retards the frequency of the pulse manifests itself on the heart through no other symptom than the prolongation of the diastole. If the vagus, as Schiff and Moleschott assert, can increase the frequency of the pulse, even in the face of high exhaustibility, at least the diastole must be shortened and contraction prolonged. Instead of this only the first is seen: prolongation of diastole." Pflüger seems to have observed the phenomena very accurately, for Howell, in 1896, agrees with him in describing the effect of vagus stimulation. How the vagus inhibits, however, and how the heart is excited to activity, are matters less easily decided. Stewart found, in 1892, that during moments of greatest intra-cardiac pressure it is most difficult to inhibit the pulsation of the heart by stimulation of the vagus. This seems to indicate that the motor apparatus is located in the muscular walls of the organ itself. Of recent

[1] Goltz: Ueber d. Verrichtungen d. Grosshirns. *Pflüger's Arch.*, XIII, pp. 1 ff.

[2] Pflüger: Untersuch. aus d. Bonner physiolog. Lab., 1865, pp. 1 ff.

times the most widely accepted explanation of inhibition by the vagus is that which Stefani proposed in 1880, and Gaskell somewhat later. The vagus is the trophic nerve of the heart. It is katabolic in systole and anabolic in diastole. The after effect of vagus excitation, says Gaskell[1] somewhat later, is to strengthen the force of the cardiac contraction and to increase the speed with which excitation waves pass over the heart. The contrary effects on the other hand appear on stimulation of the augmentor. This theory of vagus inhibition as due to trophic effects is not without positive experimental evidence, for Fantino, in the same year in which Gaskell wrote his defense of the theory, cut the left vagus in a rabbit and reported the changes which he observed in the heart wall. The animal was apparently healthy, ate well, and its weight increased. But on examination eighteen days after the operation it was found that the heart had atrophied to a considerable extent. The region over which the waste of tissue occurs, moreover, differs according as the right or left vagus is injured.

There are but three theories which have at any time received wide acceptance.[2] None of these can be sharply limited chronologically or by generally important physiological discoveries. They are tenacious of life and each overlaps the period during which the succeeding theory attained its prime.

Setschenow's Centre Theory. The first is known as Setschenow's centre theory.[3] Setschenow discovered that while stimulating the optic lobes and mid-brain of a frog reflex movements of the limbs could not be induced by peripheral stimulation as under ordinary circumstances. These parts he calls the centre for inhibition. They are kept in tone by continuous sensory impressions. This theory has enjoyed a long life. Even to-day some eminent physiologists have not positively decided against it. Tigerstedt, for instance, in 1897, gives it as his opinion, that it must be considered as undecided whether inhibitions can be explained by the centre theory.[4]

Setschenow was at first inclined to the opinion that the

---

[1] Gaskell: *Arch. de Physiol.*, 1888, I, pp. 56 ff.

[2] Of the explanations offered for particular cases of inhibition we cannot now speak, but must pass on to trace the development of the theories of inhibition in general. One of the earliest theories was offered by Schiff who believed that inhibition was merely a case of exhaustion. Pflüger held a theory of special inhibitory ganglia in the heart and intestinal walls and elsewhere, a theory which was more satisfactory at the time. There were also other minor theories, but none have more than an antiquarian interest at the present time.

[3] Setschenow: Phys. Studien über d. Hemmungs-Mech. f. d. Reflexthätigkeit d. Rückenmarks d. Frosches, 1863, pp. 1-71.

[4] Tigerstedt: Physiol. d. Menschen, Bd. II, 1897, p. 285.

inhibitory centres lie only in those parts of the brain which have been mentioned, because direct stimulation of the surface of a transverse section of the cord has not the same effect as stimulation of the optic thalami. This, however, was later shown to be insufficient, and when Herzen and Schiff showed that, in a completely debrained frog, stimulation of the posterior parts inhibits the movements of the fore limbs, Setschenow extended his theory and declared that inhibitory centres exist also in the spinal cord.

Preyer supported the theory of inhibitory centres on the ground of his observations of the phenomenon of kataplexy[1] and explained hypnosis by inhibition. Of the inability to produce violent movement during the kataplektic state, he says: "The excitation of the reflex inhibitory apparatus outweighs that of the psychomotor centres." Nothnagel in his argument for the centre theory even went so far as to ascribe to the inhibitory centres the power of voluntary activity.

It had been explained that there were definite inhibitory centres in the brain and spinal cord, and the followers of Setschenow attempted to discover the avenues through which excitations from the periphery reach these centres. Setschenow himself had considered the eye as the chief medium for this purpose, but Langendorff, on repeating Goltz's experiments on the reflex croak, and finding that by pinching the frog's toe the croak could be inhibited, concluded[2] that the skin was another avenue for these excitations. Inhibition was, he thought, purely reflex.

But, as Schlösser pointed out, if one grants all that the experiments seem to show there is no indication as to how these centres can act,[3] and further, in order to account for the numerous inhibitions actually found, the centres must be exceedingly numerous or must form a very complex system. Goltz comments upon this same difficulty as follows:[4] "Many have undertaken to assume (for the explanation of numerous experiments, which may be made clear much more simply in another way) inhibitory centres in the heart. These should be inhibitory centres of the first order. The heart is brought to a standstill by the mediation of the vagus nerve from the medulla oblongata; therefore in the medulla there would be an inhibitory centre for the heart which should be the inhibitory

---

[1] Preyer: Die Kataplexie u. d. thierische Hypnotismus, Sammlung, phys. Abhandlungen, Jena, 1875. Secs. 17-42.

[2] Langendorff: *Du Bois Reymond's Arch.*, 1877, 4 u. 5 Heft, pp. 96-115 and 435-442.

[3] Schlösser: Untersuch. über die Hemmung von Reflexen. *Du Bois Reymond's Arch.*, 1880, pp. 303-322.

[4] Goltz: Nervencentren d. Frosches, 1869, p. 50.

centre of the second order. This inhibitory centre can, however, as I have shown, be inhibited if the skin of the extremities is strongly stimulated. For this we need an inhibitory centre of the third order to bring the centre of the second order into a state of inactivity. . . . ."

Moreover, there are anatomical difficulties in the way of the full acceptation of such a theory as Setschenow's. It is a plausible theory that if there are specific centres for all inhibition there must also be special inhibitory nerves for voluntary muscles as well as for the heart and intestines. The question has been amply discussed both pro and con. Wundt tells us[1] that there are inhibitory nerves leading to muscles and to glands. They are most probably connected with the muscles by reflex inhibitory ganglia. But Amaya points out[2] that while it may be assumed that inhibitory fibres are contained in the nerve trunks they cannot be isolated from the motor fibres by any process of degeneration. A still further difficulty with the centre theory, which Setschenow himself admitted, and which shows its incompleteness, is that by it the inhibition of the tactile reflexes cannot be explained since for these Setschenow failed to find any specific centres.

The Theory of Goltz. The unreasonableness of having to explain the inhibitions of different reflexes by different theories led Goltz to offer a new explanation. This was more theoretical than the former, but its author hoped it would cover all cases. He proceeds from the inhibition of the croak in the frog, which he calls a good type of all inhibitions. The hypothesis rests upon the supposition that "a centre which mediates a definite reflex act loses excitability for this act if it is set in excitation at the same time by any other nerve tracts which are not concerned in that reflex act." The inhibition of tactual or other reflexes, says Goltz, can be explained on this theory, and this constitutes its great advantage. If a reflex frog's flank be acidized, the spot is wiped by the foot of the adjacent side, whereas the normal frog leaps away. From the ever active brain, he says, excitations are always flowing to every centre; and thus, it comes about that in the normal frog the movement to wipe off the acid is suppressed, and the movement of escape is substituted for it.

Wundt also discusses the influence of the higher centres upon the occurrence of reflexes.[3] "This point of view," he says, "casts light upon the slighter intensity of reflexes which one generally observes so long as the brain is retained. In this

[1] Wundt: Lehrb. d. Physiol., 1878, p. 528.

[2] Amaya: Ueber scheinbare Hemmungen aus Nervmuskelpräparate, I u. II, 9te u. 10te H., pp. 413 ff. 425 ff.

[3] Wundt: Mechanik d. Nerven, 2te abth., 1876, p. 100.

case simultaneously with the stimulation of the reflex organ occurs also a stimulation of the brain in which conscious sensation arises. The sensation is probably only an accompanying phenomenon and stands in no direct relation to inhibition. But according to the rule that every interfering stimulation of the central spheres in which centripetal fibres end inhibits reflexes, so in this case also, through the interference of spatially separated stimulus-effects of one and the same stimulation, an inhibition can occur."

This explanation, says Goltz, has in it many points of similarity with the theory previously offered by Herzen and Schiff, viz.: that inhibitions are due to the exhaustion of nerve centres. Herzen had said that any strong sensory excitation removes the reflex excitability of the nerve centres because they are exhausted by the intensity of the excitement. On the other hand Herzen's contention that reflexes are heightened by the debraining operation because thereafter the sensory excitations have a narrower sphere in which to be effective, is not approved by Goltz for a reason similar to that offered by Wundt, namely, that inhibitions are more intense the better the condition of the animal for the transmission of stimuli.[1] There are numerous phenomena to support this objection.

Taken as a whole the literature contains fewer direct references either of approval or condemnation of this view than that of Setschenow, but there are many who lend it their support by implication. Among these is Wundt, who thinks that when two or more excitations reach a sensory centre their effect is inhibition.[2] Howell, too,[3] says that to obtain inhibition, there must be at least two pathways by which impulses may reach a cell, and the stimuli conveyed over these different tracts must tend to excite different reactions. Inhibition, therefore, is connected with the effects of sets of impulses upon a responding cell, and this is associated with the fact that as the two paths end in different relations to the cell the impulses must enter it at different points, and hence, tend to act on different portions of the cell contents. There is enough known, he says, to conclude that inhibition does not depend upon special fibres but upon several impulses coming in by different paths. Schlösser, however, is one of those who opposes this theory.[4] He is convinced that all the phenomena of inhibition can be explained on the supposition of antagonistic centres, and is unable to find any proof for the disturbance of an excitation within the cell. In fact, such proof, it may be said in passing,

[1] Wundt: Physiol. Psychol., 5 te Aufl., Bd. I, 1902, p. 86.
[2] *Op. cit.*, Bd. I, p. 87.
[3] Howell: Am. Text Book of Phys., 1896, p. 667.
[4] Schlösser: *Op. cit.*, pp. 303-322.

cannot be experimental, and Goltz himself did not expect to find it. Tigerstedt leaves the question open. Verworn approaches the matter in an attempt to answer the question: "What relation exists between a centre and a muscle when a muscular contraction is inhibited?"[1] He was able to disprove the assertion of Starke that in inhibition of skeletal muscles the excitability of motor roots is reduced. On the other hand he says this excitability is unchanged. Hence there is no active inhibitory impulse opposed qualitatively to a motor impulse conducted to a muscle through its nerves. In other words: "The process of inhibition arising in the ganglion cell bodies of the anterior horns is not extended to the axis cylinder of the neurones, and is not transmitted through them to the skeletal muscles, nor transmitted actively in any way." He further concludes that skeletal muscles also possess no particular inhibitory fibres; that all inhibitions which occur in the skeletal muscles, *e. g.*, reflex inhibitions, are purely passive, and occur only in a central way through inhibitions of the central elements, and consequently consist only in a simple cessation or dropping out of the central excitatory impulses to the muscles. On the other hand he does not deny that active inhibitions are present whenever muscles have a particular autonomy or a particular tonus, as is the case with the muscles of the heart, blood vessels, and intestines. Here, indeed, there are special inhibitory nerves whose excitation causes an inhibition of the end organs in the muscles.

We have now seen some of the difficulties in the way of the centre theory, and also the theoretical character of the explanation offered by Goltz. It remains to speak of another explanation no less theoretical than the latter, but sharing with it a very generous share of popular approval.

The Theory of Lauder Brunton. To say that all inhibitions are due to the fact that the central nervous system does not permit its different parts to be simultaneously excited by different stimuli, leaves us in uncertainty as to how the nervous system comes to have such a property. An interference in the nerves themselves has accordingly been suggested. The first great exponent of this theory was Lauder Brunton. In its earlier stages his explanation was about as follows.[2] The excitation following a weak stimulation is carried only to a motor cell and produces movement. A strong stimulation passes over to an inhibitory cell whose activity cancels that of the motor cell, wholly or in part. This, however, did not suggest the doc-

[1] Verworn: Zur Phys. d. nervösen Hemmungserscheinungen *Arch. f. Anat. u. Phys.*, pp. 105 ff. Suppl. Abth., 1900.

[2] Brunton: West Riding Asylum Reps., 1874, pp. 179-222. See *Nature*, Vol. 27, p. 437.

trine of interference, because Munk had shown that in different nerves the rates of transmission are different, and interference cannot be used as an explanation unless the rates of transmission are the same. Later it came to be believed that under like conditions the rates are similar, and Romanes took a forward step in experimental physiology[1] which led Brunton shortly afterward to state the theory we are about to discuss.

Romanes' experiments consist in tests on a strip of Medusa tissue at one end of which is a single lithocyst. He first observed the rhythm of activity of this lithocyst and then at the same rate stimulated the other end of the strip by electricity. The waves then always passed from the stimulated point toward the lithocyst. But if the rate of stimulation fell below that of the lithocyst, after one to six waves, depending upon the degree of conformity thereto, one passed in the opposite direction. When two such waves met they neutralized each other; or the tissue on each side of the meeting point, having lately been excited, could not transmit another excitation. The facts of inhibition then are explained as due to an interference of vibrations the rates of which are not synchronous.

Brunton now formulates the theory of interference on the analogy of the interference of waves of light and sound.[2] "Motion, sensation, inhibition, or stimulation are not positive but simply relative terms, and stimulating or inhibiting functions may be exercised by the same cell according to the relation which subsists between the wave lengths of the impulses travelling to or from it, the distance over which they travel, and the rapidity with which they are propagated."[2]

The test of this theory is to be found, according to Brunton, in those variations of the conditions of temperature, etc., which change the rate of transmission in the nerves.

The effect of warmth or cold on strychnine tetanus, says Brunton, is what we should expect on the theory of interference. If small doses of strychnine are given warmth abolishes the convulsions but cold increases them; the contrary follows when large doses are given. The explanation he gives is in detail as follows: "If a small dose of strychnine retard the transmission of nervous impulses so that the inhibitory wave is allowed to fall more than half a wave length, but not a whole wave length behind the stimulus wave, we should have a cer-

---

[1] Romanes: On the Locomotor Systems of Medusæ, Philosoph. Trans., 1877, pp. 659-752. See Gen'l Summary, pp. 745 ff.

[2] Lauder Brunton: On the Nature of Inhibition and the Action of Drugs upon it. *Nature*, 1883, Vol. XXVII, p. 422. See the series of articles under this subject; same volume, pp. 419 ff., 436 ff., 467 ff., 485 ff.

tain amount of stimulation instead of inhibition. Slight warmth by quickening the transmission of impulses should counteract this effect and remove the effect of strychnine. Cold, on the other hand, by causing further retardation should increase the effect. With a large dose of strychnine, the transmission of the inhibitory wave being still further retarded, the warmth would be sufficient to make the two waves coincide while the cold would throw back the inhibitory wave a whole wave length, and thus again, abolish the convulsions."

Several other facts are offered by Brunton in favor of his theory. There is the well known phenomenon of accelerated heart activity during the act of swallowing because a part of the stimulus of the bolus, in the pharynx, passes to the centre in the medulla oblongata which is close to the root of the vagus. This nerve itself is inhibited and the heart works more rapidly. Stimulation of the sciatic nerve in a frog may inhibit the reflexes on the other side. A few hours later when conditions may be supposed to have changed, instead of inhibited response we find clonic convulsions. In the frog heart, according to the description given by Beale, Brunton finds a mechanism fitted for altering the distance two stimuli have to travel and thus allowing them to interfere with and to inhibit each other, and finally there is the observation of Mortimer Granville,[1] that by rapid percussion of a nerve already mediating a grinding pain, and by slow percussion of one mediating acute pain, he is often able to cancel the discomfort.

If we could be absolutely certain of that of which Mercier seems so confident,[2] viz.: that "nerve currents are known to be undulatory in form," and if we could be sure that, as he says, and as Loeb somewhere affirms, along every nerve fibre gushes of nerve force succeed each other as waves of blood in arteries and veins, we could more easily conclude in favor of this theory of inhibition by interference. Doubtless, as Herrick says,[3] it is the most generally accepted theory. But in the face of the fact that Wundt declares that there is no evidence for it,[4] and J. Kron, after an elaborate series of investigations in Mendel's laboratory,[5] comes to the conclusion that inhibitions are due to the changes in the supply of blood to the nervous centres, it is probably safer to do as so many others have done

---

[1] Mortimer Granville: Nerve Vibration and Excitation. London, 1883. See *Nature*, Vol. XXVII, p. 437.

[2] Mercier: The Nervous System and the Mind, p. 74.

[3] Herrick: Baldwin's Dict. of Philos. and Psychol. Art. *Inhibition*.

[4] Wundt: Physiol. Psych., Bd. I, 1902, p. 87.

[5] J. Kron: Experimentelle Beiträge z. Lehre von d. Hemmung d. Reflexe nach halbseitiger Durchschneidung d. Rückenmarks. *Deutsche Zeitsch. f. Nervenheilkunde*, 1902, Bd. 22, Dec. Heft.

before, that is, to leave the question open for further investigation.

III.

The Phenomena of Summation.

Closely allied with the phenomena of inhibition are those of summation. If the recent prevailing views concerning these functions are correct one may almost say that they represent opposite faces of the same phenomenon. The summation of stimuli, true to the etymological significance of the phrase, is a heaping up of impulses. Every one is familiar with the extreme exasperation to which one may be driven by a fly which persists in attacks upon one's forehead, and with what vigorous gestures we seek once for all to annihilate the offender. An experience scarcely less well known is the irritation caused by a small body fast within the throat. First we cough slightly, then violently, and finally, if the offense continues, we fall into a cramp and emerge therefrom in a weakened, breathless state.

At the beginning of our half century of physiological history summated stimuli were little understood, and had not been specially examined.

Helmholtz[1] early gave a clue as to how these phenomena might be explained in calling attention to the slow rate of transmission from the sensory to the motor roots in the cord. (Exner's "reduced reflex time."[2]) He estimates that this transmission required from 1/30 to 1/10 sec., a much slower rate than that of impulses in the nerve fibres. This may be taken in connection with the early observation by Schiff on frogs, that the thinner the gray matter of the cord was made between the sensory and motor roots in the single locality tested, the longer is the reflex time.[3]

These facts suggest the crowding of impulses into a narrow passageway, or into a channel which offers some resistance, the later thus overtaking the earlier and heaping up upon them until of their own accumulated energy they break through *en masse*, pass over to the motor roots and occasion violent movement. The early methods of investigation, however, were inadequate to furnish any very reliable information regarding the time that must elapse between the application of a stimulus and its motor effect, or concerning the relations of interval and stimulus number best suited to optimum results. Setschenow showed that ability to summate stimuli belongs in an especially

---

[1]Helmholtz: Ber. d. k. Akad. d. Wissensch, z. Berlin, pp. 329 ff., 1854
[2]Exner: *Pflüger's Archiv.*, 1874, Bd. VIII, pp. 526 ff.
[3]Schiff: Lehrb. d. Physiol., 1858-1859, p. 228.

high degree to the locomotor centres;[1] and that if a galvanic current be interrupted sixty times per minute, the reflex quiver occurs in a slight degree after the first interruption, and is confined to a limited number of muscles; the second, third, etc., interruptions are followed by more intensive and extensive contractions until a movement of the whole extremity follows. These experiments were with electrical stimuli. But Türck[2] much earlier and Baxt[3] somewhat later obtained the same result with chemical stimuli, and the latter set forth his law that the reflex time increases in geometrical progression while the degree of acidity of the stimulus decreases in arithmetical progression. Such a stimulus, he says, can occasion excitation only if its particles follow one another into the nerve tissue more rapidly than excitation passes away.

But the difference in the rates of transmission of different parts of the nervous system and the observation made by Schiff mentioned above did not open a way in the minds of all for the explanation. One of Schiff's own contemporaries accounted for the phenomena on the ground of the increased excitability of nervous tissue[4] and thought that this excitability can be measured by the position of the secondary coil required to produce a reflex as two, three, or four times a former excitability. Heidenhein in the same year found that muscle in a state of contraction is more excitable than at other times. Gruenhagen, however, denies that the phenomena in question are due to an increased excitability of muscular tissue or of any other tissue.[5] Pflüger had declared that during the process of death the positive forces of inhibition vanish more quickly than the forces of molecular tension. Hence when a stimulus is applied, in the absence of inhibitory forces, the nerve *appears* to have a heightened excitability. Harless, further, showed in a later work than that mentioned above that the simultaneous stimulation of two parts of the same nerve acts more strongly than a single stimulation of one part.[6] This, says Gruenhagen, is easily established.[7] The upper part of a nerve is more excitable than the lower as can be easily shown by the comparison of the effects of two electrical stimuli one passing up, the other down the nerve. No less plausible, thinks Gruenhagen, is Pfluger's

---

[1] Setschenow: Monog. über d. elec. u. chem. Reizung d. sensib., Rückenmarknerven d. Frosches, Gratz, 1868, I. sec. 12, u. a.

[2] Türck: *Zeitsch. d. Gesell. d. Aerzte*, 1850, H. III.

[3] Baxt: Arbeiten aus d. phys. Anstalt z. Leipzig, 1871.

[4] Harless: Ueber Muskelzuckungen bei dem Vertrocknen d. Nerven. München, Gelehr. Anz., XLVIII, 1859, col., 241-246.

[5] Gruenhagen: Bemerkungen über d. Summation v. Erregungen in d. Nervenfasern. *Zeitsch. f. rat. Med.*, pp. 190 ff. XXVI, 1866.

[6] Gruenhagen: *op. cit.*

[7] Gruenhagen: *op. cit.*

decision that in the absence of inhibitory forces nervous tissue possesses only apparently a higher degree of excitability than formerly. Gruenhagen assumes that in an animal in which the lower and higher nervous centres have been separated, the moisture contained in the nerves begins to evaporate. This process occasions more or less of a crumpling or folding of the nerve masses, and this in turn a stimulation of the fibres which, within certain limits, is the more intense the further the process of evaporation has proceeded. Any peripheral stimulus produces an excitation which is added to this aroused internally, and a more vigorous contraction attends a weak peripheral stimulus than in a fresh state of the nerves accompanies a much more intense external stimulus. Gruenhagen thus arrives at a conception of summation. Pflüger had shown that of two frog shanks one stimulated from the plexus, the other from the muscle itself, the former is the more quickly thrown into contraction. This, he explains, on the assumption of an avalanche-like swelling of excitations as the excitement of the plexus proceeds toward the muscle. Gruenhagen, however, prefers, in this connection, to speak of a rolling up of nerve force.

Previous to 1874 no very systematic work had been done on this subject. In that year, however, William Stirling published his work on summation[1] in which the phenomena described are discussed in detail. In none of the tables which he presents is any relation whatever to be found between the intensity of the stimuli and the time of latency. This much controverted point has been confirmed in our own times by Goldscheider. But latency does depend invariably, as Stirling shows, upon the frequency with which stimuli follow one another. Though it varies somewhat according to the part of the body as well as with the animal on which tests are made, *e. g.*, Tigerstedt shows that 27 stimuli per second produce tetanus in the gastrocnemius of the frog while 10 per second have the same effect on the red muscle soleus in the puppy. Other things equal, the shorter period of latency always accompanies the shorter stimulus interval. It is inadmissible to compare the results of several experimental series with one another even though the stimulus interval be uniform throughout for the reason that at different stages in the life of a preparation these periods vary considerably from causes which we cannot compute. For instance, with a constant interval of ⅛ second variations in latency in a series of experiments may occur between .5 and 5 seconds: with an interval of ¼ second the variations

[1] Wm. Stirling: Summation v. elec., Hautreizen, Ber. d. sächs. Acad. Math. phys., 1875, pp. 372 ff.

range from 1 to 30 seconds. As the interval increases above the optimum he shows, in analogy with Baxt's law, that the number of stimuli necessary for producing a contraction must surpass by many fold those required where a shorter interval is used.

Can any reflex movement occur without a summation of stimuli? All agree that much greater intensities of currents are required for the production of reflexes by a single stimulus than in the classical summation experiments in which a series of relatively weak stimuli are used. To find the cause of this difference Stirling compared in many ways the effect of single induction shocks with that of repeated stimuli. All apparently spontaneous movements of reflex animals he was led to put down, incidentally, to the account of summation.

To the objection that demonstrably simple stimuli may produce effects such as are attributed to summation, Engelmann replies[1] that very intense induction shocks produce chemical and thermal variations in the substance of the nerves, and Stirling has observed that a sensitive frog shank, with a single shock, is often thrown into tetanus. He would, therefore, bring single stimuli into the sphere of summation, and state it as a general law that reflexes can be called out only by repeated stimuli.

The problems of summation were later carried into a field of more immediate interest to the psychologist. Recent studies furnish some evidence of a connection of summation with sensation. Naunyn in his study of the sensation of pain[2] has found that under the conditions observed in summation experiments in general the period of latency of pain summation is the same as that of the summation of sensory stimuli for the production of reflex movements. This, however, as Naunyn recognizes, does not establish the matter beyond a doubt but only makes it probable that pain is a product of summation.

Goldscheider brings the "secondary sensation" into relation with the summation of stimuli.[3] If one's skin is pricked with a needle, after a sensationless interval an after-sensation appears which, though of varying degrees of clearness, cannot be mistaken. In the course of his experiments he found that there is no definite relation between stimulus number and stimulus interval: different intervals are favorable for a clear after-sen-

---

[1] Engelmann: Bewegungserscheinungen an Nervenfasern bei Reizung mit Inductionsschlagen. *Pflüger's Arch.*, Bd. V, pp. 31 ff.

[2] Naunyn: Ueber d. Auslösung v. Schmerzempfindung durch. Summation sech zeitlich folgender sensibles Erregungen. Arch. f. exper. Pathol. u. Pharmakol., Bd. XXV, pp. 272 ff.

[3] Gad and Goldscheider: Ueber d. Summation v. Hautreizen, Bd. I, Gesammelte Abhandlungen, pp. 397 ff. Leipzig, 1898.

sation at different times with the same number of stimuli. This variability, however, belongs only to a limited sphere. If the number of stimuli is large the variations of intervals must be slight. If the intervals are long the number of stimuli for optimum results must be almost constant. Goldscheider formulates the following law: "With increasing stimulus interval the number of single stimuli required for clearness of secondary sensation decreases: with decreasing interval the stimulus number must increase." The latency time of the after-sensation depends less upon the kind and intensity of stimuli than upon the velocity with which they succeed one another. In this respect the after-sensation is similar to the reflex movement produced by the summation of sensory stimuli.

While Goldscheider's explanation is on the ground of summation his scheme is somewhat different from that of those who attribute the phenomena of summation and inhibition to the interference of waves of excitation or of nerve force within the nerves themselves. For him the gray matter of the cord is the summation tract. When an excitation arrives from the periphery a part is transmitted directly to the centre of consciousness and a part to the cells in the gray matter described by Kölliker.[1] In these cells he supposes a change in the state of excitability. The excitation is stored up here to be discharged later and transmitted to the centre of consciousness when it is recognized either as pain or as a secondary sensation of the same quality as the primary.

IV. Vascular Tonus.

As we saw in Section I the conception of a reflex vascular tonus originated in 1852 with Claude Bernard who discovered the vaso-constrictor fibres, by the immediate influence of which the walls of the blood vessels were supposed to be kept in a tense condition. A few years later Schiff believed that he had demonstrated the presence of vaso-dilator fibres in the cervical sympathetic of a rabbit[2] and again Bernard somewhat later believed he had still more conclusively demonstrated their existence. But with this the question was not decisively settled and it has been discussed pro and con until the present time when McKendrick asserts his belief in some sort of inhibitory mechanism which accounts for the dilation of the vessels,[3] and Dastre and Morat, Howell and Porter find for interference with peripheral ganglionic mechanisms, and for antagonistic fibres

[1] Kölliker: Ueber d. feinern Bau d. Rückenmarks, Sitzungsber. d. phys. med. Gesells. z. Würzburg, 1890, p. 40.
[2] Schiff: Berner Schriften, 1856, p. 69 ff.
[3] McKendrick: Textbook of Special Physiol., 1889, p. 296.

within the nerve trunks.[1] Until, however, these fibres of opposite function can be positively demonstrated, it is simpler and more satisfactory, if we must take sides, to give preference to the theory of Dastre and Morat, and thus bring the constriction and dilation of the blood vessels into analogy with the excitation to, and inhibition of, those reflexes which are more familiar to us.

Besides this question of constrictor and dilator fibres there was another of considerably greater interest to the physiologists of the early part of our half century. Such fibres once granted, from what anatomical points in the central nervous system is the vascular system controlled?

These were sought with great zeal in the spinal cord; and Schiff first clearly stated that the vascular centres are located in that part of the nervous system. It is hardly within the scope of this paper to enter into the anatomical details. Suffice it to say that Lister, Goltz, Owsjannikow, Ludwig, Gaskell, and others of no less repute, have throughout laborious years sought for regions of predominating influence upon the circulation of the blood, and that to-day, with the addition of some details, our knowledge of this matter is practically as Lister left it in 1858: in a word that the tonus of the blood vessels depends upon the cord and local ganglia.[2]

It is of more importance for our purpose to know whether these changes in vascular tonus are reflex or automatic.

The supposition of the reflex character of the vascular phenomena has much in its favor. The experiments which were made to demonstrate the existence of vaso-constrictor and vaso-dilator fibres point in that direction; but these are not all. It had early been observed that if one hand be immersed in cold water the temperature of the other falls from one to twelve degrees C. In many such cases the temperature of the mouth and axilla rises slightly indicating that the temperature of the body as a whole is not altered. This observation was originally made by Brown-Sequard. Later he and J. S. Lombard performed confirmatory experiments. Cyon also, in 1866, declared that he had proved that the vascular centre in the *medulla oblongata* can be influenced by impressions from the periphery, *i. e.*, in a reflex manner.

The experiments by Brown-Sequard and Lombard suggested more extensive tests which were made by Putnam on frogs in 1870.[3] These experiments are of importance because they

---

[1] Dastre: *Arch. d. Physiol. norm. et pathol.*, 1882, p. 190.
[2] Lister: Philos. Transac's, London, 1858, pp. 607 ff.
[3] J. J. Putnam: A report of some Experiments on the Reflex Contractions of the Blood Vessels. *Boston Med. Jour.*, Vol. LXXXII, 1870, pp. 469–472.

show so clearly the reflex function of the central nervous system in relation to the blood vessels. The web of one hind foot, after the removal of the *medulla oblongata*, was watched under the microscope while the other was stimulated mechanically and chemically. Contraction of the vessels on the side opposite the stimulation is not absolutely invariable, but sufficiently so after all causes of variation have been taken into account, to make the assertion safe that the phenomena fall under the category of ordinary reflexes.

Putnam's conclusions fall in with an observation made by Callenfels and confirmed also by O. Bezold. Callenfels says:[1] "If one cuts the spinal nerve (to the ear) in a rabbit, an operation which causes a slight dilation in the blood vessels in the ear of the same side, one can afterward provoke a contraction of these same vessels not only by galvanizing the peripheral end of the cut nerve, but also by irritating, in the same manner, its trunk which still remains in connection with the medulla, and which is no more in direct communication with the part where the effect is produced. It must be then that an irritation has been transmitted to the cerebro-spinal axis and has there set up a nervous action which is directed toward the vessels of the ear." In this case the reflex arc between the stimulated point on the central stump and the vascular area where the effect is produced, is composed of the central stump of the severed nerve, the cord or spinal ganglion and the sympathetic fibres leading from this centre to the walls of the vessels. Much later than this Moritz Nussbaum expressed his belief in the possibility "that many sensory nerves are able reflexly to widen the arteries directly through the excitation of inhibitory centres or the relaxation of vaso-motor centres."[2] Further he says that from his investigation "it follows that the vaso-motor centre extends through the cord into the *medulla oblongata* and can be set into heightened reflex activity by all sensory nerves."

But the matter is by no means a simple one, for vascular variations occur also in the absence of the entire central nervous system, as was early shown by Lister[3] and others, given a crucial demonstration by Gergens and Werber[4] and reconfirmed by Gley in 1844 and by Goltz and Ewald[5] in 1896.

It may now be asked: What are the stimuli -the first term of the reflex series—which in normal life provokes vascular

---

[1] Callenfels: *Zeitsch. f. rat. Med.* Bd. VII, 1855, p. 157.

[2] Nussbaum: Ueber d. Lage d. Gefasscentrums. *Pflüger's Arch.* X, 1875, pp. 374 ff.

[3] Lister: *op. cit.*, pp. 617 f.

[4] Gergens and Werber: *Pflüger's Arch.*, Bd. XIII, 1876, pp. 44-61.

[5] Goltz and Ewald: Der Hund mit verkürztem Rückenmark. *Pflüger's Arch.*, Bd. LXIII, 1896, pp. 362-401.

tonus and the variations in the lumen of the vessels? It must be answered that they cannot be pointed out with certainty. Not a few of the older investigators preferred indeed to escape the need of pointing them out by calling the control automatic, though the present tendency is toward a reflex explanation, with considerable variety of opinion as to just what the stimuli are and just how they are applied.

Taking the tonus question as a whole, we see in the course of the investigations that from simple beginnings the conception of a complicated reflex mechanism has been developed. Early in the period there was a tendency to consider the vascular centres automatic, but as knowledge of the effect of both external and internal stimuli has increased the automatic theory has been given up, and co-ordinately with the growth of the reflex idea has risen also the idea of the importance of the entire organism in vascular control as opposed to that of any particular parts.

V. Muscular Tonus.

In the first section of this paper it was pointed out that the early physiologists represented by Müller and Henle had, with some exceptions, including Ed. Weber, declared their belief in a muscular tonicity dependent upon the central nervous system. Such a tonus they, as we to-day, defined as a permanently contracted state of the muscular fibres. One's characteristic physiognomy, which in popular thought is supposed to have a psychic substrate, they attributed to the state of tonus of the facial muscles. This was Henle's idea. But Wundt, much later, in a brief period of reaction from the tonus theory, declared that this can be more easily explained on the ground of temperament and the fact that the muscle substance is not completely elastic.[1]

In the later 50's the question whether there is a muscular tonus independent of mere muscular elasticity was in an unsettled state. Nor was such a term generally accepted by physiologists in the description of muscular phenomena until much later. By exact measurement Heidenhain,[2] in 1856, failed to find any lengthening of muscles after their nerves had been cut, neither did Auerbach in the same year.[3] In the face of this negative evidence, offered by men of such authority in physiology, who were two years later reinforced by Schiff,[4] the

---

[1] Wundt: Muskelbewegung, 1858, pp. 45 f.

[2] R. Heidenhein: Hist. u. Exp. über Muskeltonus. Physiol. Studien, Berlin, 1856, p. 19 ff.

[3] Auerbach: Ueber Muskeltonus, Jahresb. d. schles. *Ges. f. vaterl. Cultur*, 1856, pp. 127 ff.

[4] Schiff: Muskel. u. nerven Phys., 1858, pp. 30 ff.

phrase "muscular tonus" was fairly on its way to oblivion. "Certainly," says Wundt, "in the natural sciences we may explain phenomena by analogy with others better known. But when the number of natural forces is increased by way of explanation we are justified in mistrust and in criticism especially when no convincing proof is adduced for the creation. In the case of muscular tonus such proof is by no means furnished. We can explain the tense state of muscles without going beyond what we know to exist."[1] The constant tension of muscles, he is convinced, can be explained by elasticity.

But the fundamental experiment was yet to be made. This was performed by Brondgeest in 1860.[2] Though his earlier experiments had led him to negative results, the one in question he thought required the assumption of a muscular tonus. The sciatic nerve on one side of a spinal frog was severed and the animal was suspended by the jaw. At once the foot on the opposite side was found to form the greater angle with the median line of the body. Furthermore he concluded that this tonus is a reflex since section of the posterior roots produces precisely the same phenomena as severing the sciatic.

This work of Brondgeest's called forth many repetitions of the experiment in different forms. Hermann assumes a spinal sensorium.[3] The frog is trying to hold his foot up in its normal position when at rest and he "holds it at such a height as he can endure without exhaustion."

Cohnstein observed that a frog prepared according to Brondgeest's method, and placed in a horizontal position upon a surface of quicksilver shows no difference whatever in the position of its limbs.[4] Brondgeest's tonus is therefore due, he thinks, to the stimulus afforded by the traction of the muscles upon the skin. It is a reflex: not necessarily a constant state of the muscles in the sense of Müller and Brondgeest. Neither is it necessarily uniform all over the body. Here a group of muscles may be tense, there another flaccid. The difference between this explanation and that offered by Lombard in 1896 is only a matter of words.[5] Lombard says: "If, when one is quietly sitting, one turns one's attention to the sense impressions coming from clothes, warmth, sight, hearing, one is convinced of the multitude of impressions exciting the nervous

---

[1] Wundt: Muskelbewegung, 1858, p. 45.

[2] Brondgeest: *Arch. f. Anat. u. Physiol.*, 1860, pp. 703 f.

[3] Hermann: Beiträge zur Erledigung d. Tonusfrage. *Arch. v. DuBois u. Reichert*, 1861, pp. 350 ff.

[4] J. Cohnstein: Kurze Uebersicht d. Lehre vom Muskeltonus. *DuBois u. Reichert's Arch.*, 1863, pp. 165 ff.

[5] Lombard: Art. Am. Text B. of Phys., 1896, p. 134 ff.

system. The effect of all this is to cause motor cells to send delicate excitations to the muscles. Hence muscular tonus." Yet more convincing than any other argument for the negative was that which Schwalbe proposed after a long series of experiments.[1] Brondgeest's phenomena, he says, are due to an increased elasticity of muscles which remains behind after vigorous action and only gradually passes away. These experiments led G. Heidenhain, in 1871, to think the whole question of muscular tonus ended. And Eckhard, too, in 1879, doubted its existence. This, however, was a mistaken position.

The evidence on the positive side of the question is really preponderant and, Ferrier says,[2] in speaking of the work of Cyon and Tschirjew: "The negative results of previous experiments must, therefore, be attributed to faulty methods, and the existence of a muscular tonus, of a reflex character at least, must be considered as proven." Cyon, in 1865, showed that the excitability of the motor roots is heightened by stimulation of the sensory,[3] and several years later confirmed by exact measurement[4] the results of Steinmann who found that section of the posterior roots is followed by lengthening of the muscles. A little later Tschirjew demonstrated the same phenomena with equal exactness.[5] Thereafter there were a few isolated attempts to disprove the theory, and some investigators even in the face of these accurate scientific measurements continued to doubt; but it was not quite in accord with the facts when, in 1887, Westphal said that at that time physiologists were not inclined to admit the existence of a muscular tonus. At the present time the consensus is general in favor of the tonus theory.

Let us now turn to the question of how the tonic state is maintained. The arguments for an automatic tonus have not received very extended consideration though Foster says[6] that "it seems a matter of words whether we speak of it as an automatic or a reflex action of the cord. We may distinguish the part played by an afferent impulse in maintaining tonus from the part played by it in causing reflexes. In the former it is analogous to a supply of arterial blood in maintaining an adequate irritability of nervous substance. In the latter the impulses lead directly to a discharge of energy. And it is con-

[1] Schwalbe: Pflüger's Untersuch. aus d. Bonner phys. Lab., 1865, pp. 64 ff.

[2] Ferrier: Functions of the Brain, 1886, p. 82.

[3] Cyon: Ber. d. sächs. Ges. d. Wissensch. Math. Phys. Cl., 1865, Bd. XVII, pp. 85 ff.

[4] Cyon: *Pflüger's Arch.*, Bd. VIII, 1874, pp. 347 ff.

[5] Tschirjew: *Arch. f. Anat. u. Phys.*, 1879, pp. 78 ff.

[6] Foster: Textbook of Phys., Vol. III, p. 925, 1892.

venient to call the two by different names." It is, however, conceded that the tonus of the muscles of the blood vessels and the sphincters is automatic.

That muscular tonus, especially of the skeletal muscles, can be affected reflexly does not admit of a doubt. Sherrington cut the nerve leading to the hind leg of a cat.[1] When he stimulated the central stump the tonus of the extensor was lowered and the lower shank hung down straight. This phenomenon comes under the formula for reflex actions involving the spinal axis. Wundt says:[2] "The tonic excitations of the skeletal muscles appear to be of an exclusively reflex nature, since section of the muscle nerves aside from the accompanying quivering and elastic after-effects produces no change of muscular tension." But the arguments for automatism aside, and the reflex nature of the phenomena once granted, the question remains as to the organs mediating the stimuli for arousing the reflex.

As stated above Cohnstein in 1865 believed that the stimulus is afforded by the traction of the skin by the weight of the muscles. This theory for a long time received the most complete acceptance. But even where the skin lies in loose folds, without any tension whatever under the weight of the muscles, the latter are in a state of tonus. Experiments on frogs have proved that large portions of skin may be removed from the body without prejudicing muscular tonicity, or even interfering with co-ordinated movement which is so much under the influence of the tonicity of the muscles.

Mommsen, in 1885, reviewed arguments and experiments to show that the constant tension of the muscles is not, as Eckhard says,[3] entirely dependent upon afferent cutaneous impulses.[4] That afferent roots, however, have a function in connection with the phenomena in question, is beyond a doubt. The blocking of all afferent channels in a limb lowers the tonus of its muscles. Such a limb becomes excessively mobile and *rigor mortis* is delayed in its muscles.[5]

But how much of this result is due to the section of cutaneous afferent nerves cannot be determined. Since, as already stated, removal of an animal's skin does not cause tonus to cease entirely this state must be due in part to influence from the mus-

---

[1] Sherrington: On Inhibition of the Tonus of a Voluntary Muscle by Stimulation of its Antagonist. *Jour. of Physiol.*, Vol. XXIII, Suppl. 1898, p. 26.

[2] Wundt: Physiol. Psych., Bd. II, 1902, p. 254.

[3] Eckhard: Hermann's Handb. d. Phys., Bd. II, pp. 269 f.

[4] Mommsen: Beitrag z. Kenntniss d. Muskeltonus. *Arch. f. Path. Anat. u. Phys.*, Bd. 101, pp. 22 ff.

[5] Sherrington: Schäfer's Phys., Vol. II, p. 799.

cles. Tschirjew, whose work in connection with Cyon's is so important for this subject,[1] called attention to the fine network of intrafibrillar nerves within the muscles, and believes that these are the end organs for muscular tonus, and the centripetal nerve fibres of the muscles. The stretching of these fibres by the weight of a dependent limb, their compression by the muscles, or their disturbance by the activity of the muscles, he thinks, furnishes the stimulus for reflex tonus. Tschirjew relates some experiments with dogs in support of his theory. Such an animal is put upon his back so that his legs of their own weight are bent upon his body. The limbs are soon found to be asleep: *i. e.*, the muscles are toneless. Like phenomena under similar circumstances can be observed in men. This, Tschirjew attributes to the quiet unstretched condition of the muscles so that the nerve fibres in the aponeuroses are undisturbed.

It is impossible to demonstrate that either muscle or skin has a controlling interest in the production of tonus. By cocainization or flaying the effect of cutaneous impressions can be ruled out, but it is not possible to dispose of the muscular nerves while leaving the muscles intact.

VI. Tendon Reflexes.[2]

Closely related to muscular tonus are the tendon reflexes. In its absence they do not appear. Hence the production of knee jerk is a practical means for demonstrating the tension of muscles.

Scarcely three decades have elapsed since these phenomena were first described, but their great practical importance in the diagnosis of certain spinal diseases justifies the voluminous literature of a descriptive and experimental character which has appeared in this field within so brief a period. The tendon reflex is rarely absent in health but it is entirely abolished in tabes dorsalis, locomotor ataxy, and atrophic paralysis, and increased in diseases of the lateral columns. Further it has been supposed[3] that these phenomena have much influence in the purposeful management of movements, and that in men they are of importance in the maintenance of equilibrium.

---

[1] Tschirjew: *op. cit.*

[2] For the material of this section I am largely indebted to the exhaustive account of the subject found in Hermann Netter's Inaug. Dissert.: "Geschichte d. Lehre vom Knie-phänomen." Freiburg, 1897. The citations herein, excepting where exact page references are given, are *copied directly from Netter's work*.

[3] Saureys: Quelques réflexions sur le raison physiologique et la localisation probable du réflexe patellaire. Ref. Annales de la Soc. Belge de Neurol. V^e^ année.

The knee jerk, produced by smartly striking the patellar ligament of a dependent limb, is a typical instance of the phenomena. On such a stimulus the lower leg is involuntarily thrown forward. The jerk is by no means confined, however, to the knee. It may be produced by a similar stimulation of any ligament in the body.

The phenomenon was first described by Erb[1] who believed that it was a true reflex, analogous to those excited by cutaneous stimulation, and dependent upon an entire reflex arc. Tschirjew was the first to investigate it experimentally, and he, too, decided in favor of the reflex theory.[2] Westphal, however, looked upon it as a direct muscular contraction induced by the sudden tension occasioned by the blow upon the tendon.[3] Erb and Westphal, therefore, represent opposite poles of thought on this question and about them many supporters have rallied. The disciples of Westphal are found chiefly among English and American scientists, those of Erb among the Germans. Erb and Westphal were of the same opinion only in this,[4] that the tendon phenomena do not depend upon cutaneous impressions.

We shall first speak of the supporters of Erb and the reflex theory. Tschirjew has already been referred to as a member of this school, and the first experimental investigator of the tendon phenomena.[5] He found that the knee jerk disappears when the cord is cut transversely between the fifth and sixth lumbar vertebræ in puppies. This observation was later confirmed by Senator who found that hemisection of the cord displaces the phenomena only on the side of the cut.[6] Another indication, from the standpoint of the anatomist, of the reflex nature of the knee jerk is found in the fact, to which Sachs called attention, that the tendons themselves contain nerves.

But more convincing than any anatomical evidence are the experiments by Schultze and Fürbringer, who published their work in 1875. In one experiment on puppies the cord was cut in the upper dorsal region and the quadriceps muscle was severed from the patella. The disconnected muscle was then held above the bone, so as not to be affected by its jarring, and slightly stretched. It responded, by slightly twitching, to every stroke upon the opposite patellar ligament, but after either left or right crural nerve was severed the phenomenon

---

[1] Erb: *Arch. f. Psychiatrie*, Bd. II. 1875.
[2] Tschirjew: *Arch. Psychiatrie*, Bd. VIII.
[3] Westphal: *ibid.*, Bd. V.
[4] Tschirjew: *op. cit.*
[5] Tschirjew: *op. cit.*
[6] H. Senator: Ueber Schnenreflexe u. ihre Beziehungen z. Muskeltonus. *Arch. f. Anat. u. Physiol.*, 1880, pp. 197 ff.

could no more be produced in any way. Their conclusion is that in the tendon phenomenon we have not to do with a mechanical muscular contraction mediated directly through the tendons, but with a reflex mechanism whose arcs for the lower extremities pass through the lower parts of the cord. Gowers, Buzzard, Prevost and others also have decided in favor of the reflex theory, and Sternberg, in a series of articles,[1] makes the evidence practically decisive. He shows that a muscle may be severed from its ligament, lifted from the bone and turned back into a reversed position without influencing the tendon phenomenon.

Of another nature are the experiments by Tschirjew, Rosenheim and others. They measured the time of latency between stimulus and knee jerk and compared it with the latency period in recognized reflexes and in direct muscle stimulation. The time measured by Tschirjew is too long to lend color to the theory of direct muscle stimulation, and Rosenheim[2] never found a shorter period than .025 second: this and even greater periods corresponds to the latency times of undoubted reflexes. Rosenheim further computed the distance from the knee to the spinal cord and concluded that the latency time found by him is about such as should be expected under the conditions of an ordinary reflex.

Of the same character as these are a number of experiments performed by A. D. Waller which are construed as support for Westphal's theory of direct muscle stimulation.[3] He found that the latency time of the knee jerk in men is about .03 seconds, which, he says, is so much shorter than the latency of a true reflex that this phenomenon must be considered a result of direct muscle stimulation. But since the latency of the lid reflex is only .05 seconds (Exner) the difference is hardly sufficient to be convincing. Of more significance for this theory are his experiments on puppies. With direct electrical stimulation of the *rectus femoris* the latency time is .0076 second. The tendon phenomenon of the same muscle is .008 second, while the time between a cutaneous stimulus and a true reflex he gives as .033 second. Obviously the meaning of this comparison depends upon the place and conditions of cutaneous

---

[1] Sternberg: Sehnenreflexe bei Ermüdung, *Centbl. f. Phys.*, 1887; ditto: Ueber Sehnenreflexe, Verhandl. d. Cong. f. innere, Med., 1890; ditto: Monogr. Die Sehnenreflexe, etc., Leipzig, u. Wien, 1893.

[2] Rosenheim: Exper. Unters. d. unter den Namen "Sehnenphänomene" bekannten Erscheinungen unter möglichsten Berücksichtigung vom Versuchen am Menschen u. patholog. Unters., *Arch. f. Psychiatrie u. Nervenheilk.*, XV.

[3] Waller: On the physiol. Mechanism of the phenomena termed "Tendon Reflexes." *Jour. of Phys.*, XI, pp. 384 ff.

stimulation. In another communication[1] he compares the distance of the gastrocnemeus and rectus from their spinal centres as ½m— 1m. The delay in the peripheral nerve, therefore, according to his computation, if the phenomenon is a reflex, should be .02-.03 second and .04-.06 second, plus the central and muscular latencies. As a matter of fact, however, they are about the same: .03-.04 second. De Watteville also argues for the direct stimulation theory on the ground of difference in latency times.[2]

It is unnecessary to go into the details of other analogies between the tendon phenomena and recognized reflexes. Suffice it to say that Sterling and Kronecker, Rosenheim, Jarisch and Schiff[3] all find that the knee jerk is subject to the law of summation of minimal stimuli and that Prevost and others have produced the crossed phenomenon.

The reflex theory, indeed, is in so general favor that we may fairly cease speaking of "tendon phenomena" and substitute therefor "tendon reflexes."

VII. Direction of Transmission and Co-ordination of Reflexes.

It was pointed out in the first section of this study that Pflüger's Laws represent the last important stage in the development of our knowledge of reflexes in the period previous to that which we are reviewing.[4] It is now our task to see how these laws have stood the test of fifty years and in connection with them to introduce some other matter of wider general interest.

The laws were for a long time generally accepted. But there are exceptions to each of them and in the light of present knowledge they hardly merit the importance that has been given to them. The contraction of muscles does not always occur on the side of the stimulus. It often occurs on the opposite side, depending upon the intensity of the stimulus—a contradiction of the first law. It is not always true that a unilateral reflex, if it spreads, involves the symmetrical opposite muscles. In the course of numerous experiments on dogs, Goltz was impressed with the vigor with which diagonally crossed reflexes occur after the cord has been separated from the inhibitory influence

---

[1] Waller: Muscular Symptoms known as Tendon Reflex. *Brain*, Vol. III, pp. 179 ff.

[2] de Watteville: On Reflexes and Pseudo-Reflexes., *Brit. Med. Jour.*, May 20, 1882.

[3] Jarisch u. Schiff: Unters. über d. Kniephänomen. *Weiner med. Jahrb.*, 1882.

[4] A statement of these laws is given by Dr. Hodge in his sketch of the earlier history of reflexes. *Am. Jour. of Psy.*, Vol. III, pp. 359 f.

of the brain.[1] Gergens also, working with dogs, found the same crossed phenomena.[2] If the left side of a spinal dog's neck be lightly tickled the right hind leg performs scratching movements. This phenomenon is invariable under these conditions with dogs. That it is independent of any volitional activity on the animal's part is indicated by the fact that however vigorous are the scratching movements the animal appears totally indifferent to them. Luchsinger added to these tests a number of experiments on tritons and lizards and substantiated the earlier observations.[3] With frogs, however, he was unable to induce a crossed reflex. Again the same author performed analogous experiments on the cricket and carabus, creatures with six legs.[4] These were painted with ether and thus made reflex. By the aid of a pair of tweezers he made walking movements with the middle leg on one side of the cricket and the diagonally opposite hind limb moved likewise. The carabus, which, unlike the cricket, uses all three pairs of legs for locomotion, under a like test on a front leg reflexly moves the diagonally opposite middle leg and the hind leg diagonally opposite the latter. On the other hand, says Sherrington, "in the spinal rabbit the crossed reflex from one hind limb to the other is not an asymmetrical movement but a symmetrical flexion."[5] This, as Luchsinger saw,[6] has its explanation in the normal mode of locomotion of the animal in question. Crossed reflexes in the locomotor organs occur in animals which propel themselves as the dog and cat; symmetrical reflexes in hopping animals such as the frog and the rabbit. There are thus exceptions to the second law.

The abduction of the tail from the point attacked, when it is intensely stimulated, is a well-known exception to the third law.

And as to the fourth law, viz.: that the spread of a reflex excitation is always toward the head if a spinal nerve is originally stimulated, there are numerous contradictions. The experiments, described below, made by Mendelsohn, show that irradiation may occur from the head tailward. On this point Sherrington says:[7] "From the pinna may be excited move-

---

[1] Goltz: Ueber d. Verrichtungen d. Grosshirns. *Pflüger's Arch.*, Bd. XIII, p. 1 ff.

[2] Gergens: Ueber gekreuzte Reflexe. *Pflüger's Arch.*, Bd. XIV, pp. 340–341.

[3] Luchsinger: Ueber gekreuzte Reflexe. *Pflüger's Arch.*, Bd. XXII, pp. 179–180.

[4] Luchsinger: Zur Theorie d. Reflexe. *Pflüger's Arch.*, XXIII, pp. 308 ff.

[5] Sherrington: Schäfer's Textbook of Phys., Vol. II, p. 822.

[6] *Op. cit.*

[7] Sherrington: Schäfer's Physiol., Vol. II, p. 823.

ments of all the limbs, the neck, the tail, and trunk. The irradiation from this reflexigenous area usually presents the following order: 1, Neck and homonymous fore limb; 2, homonymous hind limb; 3, tail and trunk on both sides; 4, contralateral hind limb; 5, contralateral fore limb. From the fore foot can be excited, besides movements of the fore limb itself, movements in the other limbs and tail." Recently there appeared a paper by the same author which grew out of a successful attempt to find detailed evidence of aborally running reflex spinal paths.[1] He found that "Each spinal segment (in the dog) possesses a wealth of neurones with backward running axons connecting it with practically all the spinal segments behind itself,"[2]—one more piece of evidence that the fourth law does not hold good in the mammalian spinal cord. With all this, however, especially in the case of the "long reflexes," it is difficult to predict the course of an excitation. Very often it happens that, for no reason that can be discerned, the usual course of dispersion of excitation is unused and an unusual one chosen.

It appears, therefore, that different portions of the cord are, as Rosenthal thought, differently suited to the transference of reflex excitations. But this investigator believed that normal reflexes are made possible chiefly through the mediation of the *medulla oblongata* and also through the uppermost parts of the cord. The exhaustive experiments by Mendelsohn sufficiently test the latter conclusion and furnish additional contradictory evidence regarding the validity of Pflüger's fourth law. In his first communication[3] he confirms Rosenthal so far as reflexes occasioned by weak stimuli are concerned. For the effectiveness of such stimuli the integrity of the upper part of the cord is necessary. Their effect is prejudiced if a cross section of the cord be made a few millimeters above the brachial plexus, or if a longitudinal median section is made from above to the same point. These statements apply only to the occurrence of reflexes on the side opposite the stimulus which is applied to a hind extremity. The upper part of the cord is therefore more open than the lower to the transmission of excitations. In the second communication[4] the author discusses the effects of hemi and total cross sections of the cord just below the brachial plexus in the mid-dorsal region, and just above the exit of the nerves for the lower extremities.

---

[1] Sherrington: Observations on some Spinal Reflexes and the Interconnection of Spinal Segments. *Jour. of Phys.*, Vol. XXIX, p. 58.

[2] *Op. cit.*, p. 96.

[3] Mendelsohn: Berlin Akad. d. Wissensch., 1882, pp. 897 ff. See also *Arch. f. Anat. u. Physiol.*, 1883, *Phys. Abth.*, pp. 282 ff.

[4] Mendelsohn: Berlin Akad. d. Wissensch., 1883, pp. 123 ff.

In the case of hemisection and stimulation on the injured side the excitation may cross from the stimulated hind leg to its opposite and from thence to the fore extremities in weakened degree. Longitudinal median section between the brachial and lumbar plexuses only weakens the reflexes, but total transverse section in the dorsal part causes reflexes in the anterior limbs wholly to disappear. This series furnishes sufficient proof that reflex excitation is not fatally confined to any definite tract in its headward progression.

In Mendelsohn's third article[1] we find again, beside a confirmation of the preceding conclusions, another contradiction of Pflüger's fourth law. The excitation following a stimulus of the right fore foot spreads toward the hind limbs although with more difficulty than in the opposite direction. Sherrington, too, has shown that in a dog with hemisected cervical cord the scratch reflex can be readily produced on the side of the lesion by tickling the shoulder or neck.[2]

Thus at different parts of the cord the ease with which the transmission of excitation occurs, is what is to be expected from the segmental character of the spinal axis in so far as it is segmental in a functional sense. Instead of a supreme centre for the co-ordination of reflexes which was once supposed to exist in the upper parts of the spinal axis, it is now held that the cord is composed of a great number of parts more or less independent and capable of caring for a definite group of reflexes. Physiologists have been gradually led to this conception of the reflex functions of the spinal cord through the long line of researches extending from those of Lister, described in the section on Vascular Reflexes, to the work of Goltz, who tells us that the clasping reflex of the male frog is possible though the whole cord save a small portion in the brachial region be removed. Later experiments on the dog by the same experimenter[3] are suggestive of a similar division of function. But to Schrader, a little earlier than this, we are indebted for far-reaching experiments and for a clear-cut statement regarding the segmental character of the cord. He says:[4] "The series of experiments we have given teaches us that the central nervous system of the frog can be divided into a series of sections, each of which is capable of performing an independent function. It brings the central nervous system of the frog into closer relation with the central nervous system of the lower

---

[1] Mendelsohn: Berlin Akad. d. Wissensch., 1885, pp. 107 ff.

[2] Sherrington: *op. cit.*, p. 90.

[3] Goltz: Der Hund mit Verkürztem Rückenmark. *Pflüger's Arch.*, Bd. LXIII, 1896, pp. 362 ff.

[4] Schrader: Zur Physiol. d. Froschgehirns. *Pflüger's Arch.*, XLI, 1887, pp. 75 ff.

forms, which consists of a series of distinct ganglia that are connected by commissures. It speaks against the absolute monarchy of a single apparatus, and against the existence of different kinds of centres, and invites us to seek for the centralization in a many-sided coupling of relatively independent stations."

More striking than all other reflexes, because more accessible to the unaided eye, are the co-ordinated purposive movements of spinal animals, and their so-called spontaneous movements. The beheaded eel, *e. g.*, leaps from the heated water into which it is thrown.

Long before our period it was known that the spinal frog will wipe an acidized spot on its abdomen as if to remove the offending substance. On the other hand if the same spot be pinched by a pair of tweezers, one or both hind feet are used to push away the instrument: no attempt is made to stroke the injured surface.[1] This is a typical case of co-ordinated reflexes. In so far as the movement is adapted to reach an end it is purposive. The same sort of purposive co-ordination Gergens describes in the spinal dog.[2] When the breast or neck of such an animal is tickled the opposite hind limb is brought up to scratch the spot. Apparently, however, these movements are not always purposive. For instance a spinal dog resting upon his fore legs extended, and lying upon one hind hip—the familiar position of a resting dog—when stimulated in the way just described, often moves his hind leg in such a direction that it cannot reach the stimulated spot. Yet Gergens in an attempt to defend the purposive character of even such movements, says:[3] "In view of these facts I may assume that the new excitation centripetally conducted during the performance of the reflex act of movement, even without the end aimed at, to wit: the removal of the stimulus, is sufficient to weaken in a certain measure the state set up by the stimulus in the portion of the central organ in question." The same author made other experiments on the spinal frog which illustrated another case of co-ordinated purposive action. The spinal frog whose toes of one hind foot are stimulated, after a time thrusts the foot under its body as if for protection.[4]

Thus far we have spoken only of the co-ordinated movements of single members. The movements of locomotion even,

---

[1] Pflüger: Der sensor. Functionen d. Rückenmarks, Berlin, 1853, p. 18.

[2] Gergens: Ueber gekreuzte Reflexe. *Pflüger's Arch.*, Bd. XIV, pp. 340 f.

[3] *Op. cit.*, p. 343.

[4] Gergens: Einige Versuche über Reflexbewegung mit dem Influenz-Apparat. *Pflüger's Arch.*, XIII, 1876, pp. 61 ff.

in simple spinal animals, though imperfect are yet decidedly impressive. They are of different degrees of perfection in animals of different grades. To refer to the beheaded eel again: it is evidently able to perform co-ordinated locomotor movements.[1] Tarchanoff found that beheaded ducks for a few hours after spinal transection perform quite elaborate movements,[2] They swim, dive, steer with their tails, and attempt to fly from the water. Even after they are totally beheaded their movements are no less complex and orderly. By section at different parts of the cord the author is led to decide that the co-ordinating centre for these movements is in the lumbar portion. Whether they are purely automatic or reflex is a matter he cannot decide. The spinal frog, too, Sherrington says[3] is capable of co-ordinated locomotion. "In the spinal frog placed in water warm enough to form a skin stimulus, *e. g.*, 36° C, I have seen co-ordinate swimming, for a short time vigorous, and executed with the normal bilateral stroke of the hind limbs. But the total co-ordination is distinctly less good than when metencephalon and myelencephalon remain. There is a tendency for the animal to dive deeper and deeper in the water: this seems due to the sunken position of the head: the loss of the semicircular canals cannot be without importance for this condition." The spinal turtle and the snake by proper stimulation move forward co-ordinately,[4] and Bickel confirms Sherrington and others in the declaration that the spinal frog can either leap or swim.[5] These phenomena occur, however, only in cases extremely successful in an operative sense. Such examples point to a vast functional complexity in the spinal cord.

Considerable attention has been given to attempts at a physiological and anatomical explanation of spinal co-ordination. Sanders-Ezn in 1867 concluded, as a result of acid stimulation of different parts of the bodily surface, that a definite movement is produced by the stimulation of every distinct point of the skin.[6] With equally intense stimulus an almost constantly typical form of movement is produced. Sherrington says that he has seen the point of stimulation profoundly influence the reflex reaction. "Of the four senses which pre-eminently furnish space perception, one has its end organs in the skin, an-

[1] See Bickel: Ueber einige Erfahrungen aus d. vergleichenden Physiol., etc., *Pflüger's Arch.*, Bd. 83, pp. 155-159.

[2] Tarchanoff: Ueber automatische Bewegungen bei enthaupteten Enten, *Pflüger's Arch.*, Bd. XXXIII, pp. 619-622.

[3] Sherrington: Schäfer's Phys., Vol. II, p. 818. See also: The spinal Animal, *Med. Chir. Trans.*, Vol. LXXXII, p. 468.

[4] Bickel: *op. cit.*, p. 160.

[5] *Op. cit.*

[6] See Gergens: *Pflüger's Arch.*, Bd. XIII, p. 61.

other in the musculo-articular structures, and these are therefore in great measure spinal senses. It is not surprising, then, that *per se* the locus of the stimulus is for a spinal reflex an important determinant of the resulting movement."[1] But Gergens earlier[2] was led to believe that the locus of the stimulus is of less moment. When the toe of a spinal frog was lightly stimulated by electricity the foot was thrown out and drawn back to a different position. After stimulation at the same point a second and third time, etc., it was drawn back always to a new position and finally thrust under the body as described above.

The internal mechanism for co-ordination is yet a matter for speculation. It is more fruitful for us to inquire regarding the co-ordinating mechanisms in the large. When the bulbo-spinal frog is turned upon his back he rights himself. In explanation of such phenomena as this Steiner supposed a "righting centre."[3] But as Loeb justly says:[4] "He does not consider the possibility that contact stimuli and the irritable structures at the periphery may be sufficient for this reaction." Further he suggests that if we grant a "righting centre" in this case we shall be tempted to posit a "flying into the flame centre" for the moth. Thus the positing of centres can go on to infinity.

The theory proposed by Longet in 1842 in the main is still current.[5] "The primary condition of harmony in movements is found in the very sensation of their accomplishment. In effect how should one suppose that a man or an animal who has lost the sensation of movement executed by its members, and is not able to judge of their position, of their connection with external objects, and does not even know, so to speak, that they exist, and finally does not sense with its members the ground on which it rests, how should one suppose that such an animal is able to walk regularly, to preserve its equilibrium and to do this with energy, promptitude, and primary harmony? In this case the will has only a very incomplete effect upon the muscles: for one must not be surprised at the considerable disturbance which a profound lesion of the posterior medullary fasciæ occasions in the locomotor functions, since these fasciæ preside exclusively over sensibility." Claude Bernard in 1858 furnished strong proof for the correctness of Longet's theory.[6] Want of purposiveness in movements follows section of the sensory nerve.

---

[1] Sherrington: Schafer's Phys., Vol. II, p. 832.
[2] *Op. cit.*
[3] Steiner: Central Nervous Systems, I, 1890, p. 39.
[4] Loeb: Phys. of the Brain, 1900, p. 182 (note).
[5] See *Pflüger's Arch.*, Bd. XXXVII, p. 618.
[6] Claude Bernard: Leçons sur la phys. et la pathologie du système nerveux, I, 1858, pp. 246 ff.

While this view is in the main yet held as correct, it has been somewhat modified. Talma, for example, has conclusively shown that of the sensory nerves those of the muscle sense are vastly more important for co-ordination than the cutaneous nerves.[1] If the posterior spinal roots of a frog be severed it is able to move clumsily if at all. If only the skin, on the other hand, be removed, co-ordinate locomotion still occurs. When the posterior roots from one limb are cut and the opposite normal limb is stimulated the injured one moves, if at all, very slightly and without the character of purposiveness. Such an operation has the same effect before as after decapitation. But after section of the cord movements occur in less degree. Hence he concludes that reflex movements depend not only upon the intensity of the stimulus and not alone upon the integrity of the motor tracts. In his experiments these were left intact, and yet section of the sensory nerves effected a considerable modification of these muscular effects. The law of Longet cited above he modifies as follows:[2] "Because the interruption of the function of the sensory nerves very profoundly influences the movements arising in the cord, a chief condition for the harmony of movements, even for the cord, must be laid in the perception of the movement occurring. Because a cord which has lost the sensation of movements does not permit the muscles to move regularly and with their former energy, precision, and harmony, it must normally judge the position of the peripheral parts and their relation to the external world in about the same manner as the brain."

"The fact that the reflex movements, under the dominion of the cord, arising in the limbs without feeling, are much less purposive than in the normal limb, proves that the idea of the presence of a part is an important condition for the delivery through the cord of motor impulses for this part."

In Talma's work we have evidently a recurrence to the notion of a spinal cord soul which co-ordinates the movements of spinal animals. This doctrine, as we have said, was stoutly defended by Pflüger. It has occasionally arisen again since the beginning of our half century, notably in the minds of Gergens, Luchsinger, Lewes and Lange.

VIII. Theoretical Considerations.

Pflüger ascribed the movements of spinal animals to the control of a part of a divisible soul. The purposive co-ordinated movements of reflex preparations were adduced as support for this

---

[1] Talma: Eine psy. Function d. Rückenmarks, *Pflüger's Arch.*, Bd. XXXVII, pp. 617-623.

[2] *Op. cit.*, p. 621 f.

view.[1] Lotze opposed this doctrine. The spinal animal for him was a machine, but not of the first construction. Those of a scientific turn of mind eagerly grappled with this idea because it promised to make it possible for physiologists to approximate toward exact scientific research. If Pflüger's theory were correct physiology would be difficult as a science. The influence of an independent soul changing of itself and moving things, could hardly be calculated.

Goltz demonstrated to his own satisfaction that the brainless frog does not possess a soul in the sense in which Pflüger uses the term: namely, a deliberative consciousness.[2] He supports the Lotzeian theory.[3] His experiment with the normal and the beheaded frogs in gradually heated water,[4] attracted wide attention because by many it was regarded as proof positive of an unconscious spinal cord. The beheaded frog rests quietly and allows itself to be cooked whereas the normal animal leaps from its danger.

Wundt, however, while admitting the value of this test, says that it does not finally prove the lack of consciousness.[5] No objective test can inform us of the presence or absence of consciousness in another individual. The strongest proof for the cord's unconsciousness lies in the fact that in our hours of sleeping we move our bodies without awareness at the time and the act is not subject to recall. To this the objection is raised that a dull consciousness such as the cord possesses must have a short memory. Further, says Wundt:[6] "If, therefore, after the loss of the brain, movements remain which have the completest similarity with voluntary movements, it does not follow that in fact these are voluntary movements. If they are instinctive activities, however, they rest just as little and as much upon pure mechanism as the voluntary movements themselves. This distinction of mechanism and pure psychic activity is, so soon as one grants that consciousness is a product of the development of the unconscious soul, no more valid." These movements are instinctive. In essentials Wundt agrees with Lotze, but takes exception to the Lotzeian declaration that an animal body whose soul has had no experiences could not perform movements after decapitation. Says Wundt:[7] "We may, resting upon the law of heredity,

[1] See also Hermann: Archiv v. DuBois u. Reichert, 1861, pp. 350 ff.

[2] Goltz: Nervencentren d. Frosches, 1869, p. 100. See also Königsberger med. Jahrb., Bd. II, p. 189.

[3] Goltz: Nervencentren, etc., p. 82.

[4] Goltz: Nervencentren, etc., pp. 127 ff; see also Königsberger med. Jahrb., Bd. II, p. 218.

[5] Wundt: Menschen- u. Thierseele, Bd. II, 1863, pp. 427 ff.

[6] *Loc. cit.*, p. 433.

[7] *Loc. cit.*, p. 434.

express the supposition that what enters ready made into the life of the single cell is a product of the development of preceding generations, so that the arousal of those purposive and unconscious movements can be derived from a practice which is not limited to the individual life." Wundt believes there are grades of consciousness, and even in acephalous animals, consciousness "has developed co-ordinately with the whole body. He says:[1] "The soul is separable and must be in so far as it consists in a series of separated functions."

Other support for the Lotzeian theory is furnished in the experiments by Steiner on the beheaded shark. The fish is first operated upon so that in swimming it performs circular movements. Ten hours afterward when it is beheaded it continues to swim in a circle. This, he thinks, is the after effect of the former experience.

But before going on to the more purely mechanical views we must attend to a strong reversion toward Pflüger's theory.

G. H. Lewes proceeds from the assumption that identity of tissue carries with it identity of physiological property, and that similarity in the structure and connections of organs involves corresponding similarity in function.[2] The histological identity of the brain and cord is more and more confirmed by microscopic investigations. In the concluding paragraph of the article cited he distinguishes between spinal soul and sensibility: "In conclusion," he says, "let it be observed that unnecessary obstacles are thrown in the way of rational interpretation when connotative terms such as spinal soul are adopted. It is one thing to assign a general physiological property, such as sensibility, to the nervous centres; another thing to assign a term which is the abstract expression of the connexus of sensibilities to any one centre. In saying that the spinal cord is *a* seat of sensation, it is not meant that it is *the* seat, nor that the sensations are specifically like the sensations of color, of sound, of taste, of smell; but they are as like these as each of these is like the other." Nowhere does Lewes define himself more clearly.

His views are more fully elaborated in the Physical Basis of Mind.[3] Objectively a sensation is a phenomenon of movement but it is separated from other phenomena by the specialty of its conditions. It is not purely mechanical. It has the character of selective adaptation which separates it from the movement of machines: that is, it combines motor impulses to suit the varying requirements of the effect to be produced. Sensibility,

[1] *Loc. cit.*, p. 436.
[2] Lewes: Sensation in the Spinal Cord, *Nature*, Vol. IX, pp. 83 f.
[3] Lewes: Physical Basis of Mind, 1877.

on the other hand, represents the property of grouping and combining stimulations.[1] The only ground for denying sensation to the cord rests in the assumption that the brain is the sole seat of sensation.[2] The lack of uniformity in reflex actions he argues is evidence of sensation. It belongs to every segment.[3]

But sensation has two opposite faces: the objective and the subjective. On the subjective side it is consciousness. Since we know that certain actions are consequent on certain perceptions we are justified in inferring that whenever the actions are performed, the perceptions preceded them. That the perception may have stimulated the action and yet been unaccompanied by consciousness is not evidence to the contrary. We read without consciousness of the separate letters and yet are not reading automata. So far as these actions are dependent upon vital processes they are not expressible in mechanical terms. Vital facts, especially facts of sensibility, have factors neither discernible in machines nor expressible in mechanical terms.[4] According to Lewes' theory, so long as neural processes continue in the separated parts of the body we may speak of a soul separable with the body.

Talma sees the reflex phenomena in the same light as Lewes. After reviewing his experiments on the co-ordination of reflexes he says:[5] "These experiments appear to me to furnish indisputable proof for the existence of a spinal cord soul in so far as one understands thereby a complicated action in the nerve cells, as it is generally assumed in the cells of the brain,—one which determines the kind and the mode of movements following upon sensory stimulation." Luchsinger before him had called attention to his own observation that the spinal frog will turn toward a gentle stimulus but away from a severe one and concludes:[6] "The desouled animal knows how to adjust itself with the greatest nicety to external circumstances." Consciousness, says Maudesley,[7] attends the formation of neural plexuses. It is our business to investigate the conditions not of a general consciousness but of a number of particular ones. And Marshall utters a similar view when he says:[8] "Only the

---

[1] *Loc. cit.*, p. 361.
[2] *Loc. cit.*, p. 516.
[3] *Loc. cit.*, p. 556.
[4] *Loc. cit.*, p. 361.
[5] Talma: Eine psychische Function d. Rückenmarks, *Pflüger's Arch.*, XXXVII, p. 621. See also the preceding section of this study.
[6] Luchsinger: Zur Theorie. d. Reflexe, *Pflüger's Arch.*, Bd. XXIII, 1880, pp. 308 ff.
[7] Maudesley: Physical Conditions of Consciousness, *Mind*, 1887, pp. 489 ff.
[8] H. R. Marshall: Consciousness and Biological Evolution, *Mind*, No. XXXV, 1896.

brain consciousness falls under the scope of introspective psychology, but logical considerations lead to a widening of the limits of consciousness and to the hypothesis that there is a certain mentality connected with each neural action which gives us consciousness of different grades under certain conditions of neural systematization."

Of the same school of thought is Lange who takes up the question where Pflüger left it, but tries to avoid his error: that of personification. Pflüger's experiment is more valuable and fundamental than Goltz's in which it was believed that the presence of consciousness in the spinal animal was disproven. He says:[1] "Let us drop personification: let us cease to seek everywhere, in the parts of the frog, thinking, feeling, acting frogs, and try instead to explain the phenomena out of simpler phenomena, *i. e.*, from reflex movements, not from the whole, the unexplained soul. Then we shall easily discover, too, that in these already so complicated sequences of sensation and movement there is afforded the beginning of an explanation of the most complicated psychological activities. This would be a path to follow up." Lange puts his faith in modes of consciousness as Lewes does. In reply to Moleschott's statement that the whole spine may be made inactive without consciousness being affected, he says:[2] "Good! But when it is concluded that decapitated creatures have no sensation and no consciousness, Moleschott overlooks that the head separated from the spine might show its consciousness in a way we can understand, but not the trunk What sensation and what consciousness there may or may not be in the spinal centres when separated from the head we cannot possibly know. This only we can certainly assume: that this consciousness can do nothing that is not based in the mechanical conditions of the centripetal and centrifugal nerve conduction and the constitution of the centre."

But we must follow out further the direction set by Lotze. In one of his own later statements he emphasizes the subordinate position of mechanism:[3] "We cannot be surprised at the steadfastness with which the philosophy of the feelings here seeks to oppose itself as a higher view of things to the convincing representations of the mechanical view of nature. On the other hand there seems all the more necessity for an attempt to show the inocuousness of this view, which, when it forces us to sacrifice opinion that seems to be a part of our very selves, yet by what it gives back makes it possible for us to regain the satisfaction we had lost. And the more I myself have labored

---

[1] Lange: History of Materialism, 1892, Vol. III, p. 127.
[2] *Loc. cit.*, pp. 127-128.
[3] Lotze: Microcosmus, p. 46, Vol. I, 1885.

to prepare the way for the acceptance of the mechanical view of nature in the region of organic life—in which region this view seemed to advance more timidly than the nature of the thing required—the more do I now feel impelled to bring into prominence the other aspect which was equally near my heart during all those endeavors."

His earlier representations were mediating views and were easily interpreted as favorable to either side. "But all the same it is in such mediation alone that the true source of the life of science is to be found: not, indeed, in admitting now a fragment of the one view, and now a fragment of the other, but in showing how absolutely universal is the extent and at the same time how completely subordinate the significance of the mission which mechanism has to fulfill in the structure of the world."

Then as to the spinal soul:[1] "We may speak of a divisible soul, if we are thinking merely of the . . . . . predisposition to mental life which seems to pervade the body: but if the divided subject be supposed to be the already developed consciousness with its remembrances and experiences, and the dexterities and knowledge acquired by means of these, we could have no clear idea of what we are saying. Yet only a divisibility of the latter kind could account for the phenomena: for the capacity of acting in accordance with circumstances would be secured for the headless trunk not a whit more easily by means of an intelligence having no experience than of a purely physical mechanism as first formed. Hence there is a choice of only two views. Either we must regard the purposive character of the movements of headless cold-blooded animals as the result of an intelligence but of an intelligence not now present in the animal, but belonging to that one soul with whose seat the trunk was once in connection and from whose deliberations proceed habits of purposive actions in the central organ and continue even after all connection between it and the soul has been done away with. Or if we conclude that they must be accounted for not by echo but by the direct presence of intelligence, there is nothing to prevent us from admitting in the spinal cord a plurality of individual beings of the nature of souls, each of which might have an intelligence for itself."

In the purposive movements of spinal animals Sherrington sees nothing psychical. A mechanical explanation is all that is necessary. He says:[2] "The joints and muscles of the limb

---

[1] *Loc. cit.*, p. 337.
[2] Sherrington: The Spinal Animal, Med. Chir. Transacts., Vol. LXXXII, p. 466.

have been evolved contemporaneously and together in the history of the individual and the species. No muscle can therefore be thrown into action which will move the limb in any way which is an unnatural direction." And like this is Wundt's latest word:[1] "Adaptation can never be any other than a result of elementary practice processes. At the same time it is, however, a more complex process, since its essential character consists in a plurality of exercises which produce a definite purposeful total consequence."

When Pflüger's point of view is modified as it is by Lewes and Lange it can be neither proven nor disproven by introspection. On the other hand it seems difficult to account for complicated adaptations, either in spinal animals or in the lowest living creatures, on the assumption of a pure mechanism of either the first or the second construction. Wundt believes that in the lowest animals movements are accompanied by some degree of mentality. "In the lowest animals all movements possess not the character of reflexes . . . . . . but the character of psychically conditioned movements."[2]

The soul, as Pflüger used the term in his discussion of its divisibility, is an abstraction. It is beyond the reach of empirical investigation. Lotze in his earlier discussions to which reference has been made herein, also had the notion of an abstract soul set over against a concrete mechanism. But as has just been pointed out, in a later discussion he admits a different definition: one which corresponds closely to modern definitions. He has told us that the soul is divisible in so far as it is a predisposition toward mental life. This looks toward the objective face of the question.

Reviewing the history of the fifty years with reference to progress in the theory of reflex action we see clearly that the main gain has been rather in the slow alteration of standpoints than in any sudden appearance of new facts wholly incompatible with older views. The spirit of the age—its unconscious metaphysics—has changed and along with it the metaphysics of the reflex. But a point has been reached at last at which, in the opinion of the writer, at least a partial solution of the question as between the views of Pflüger and Lotze is possible.

Putting away abstract considerations, we may define the soul objectively as that feature of the central nervous system in virtue of which the organism is enabled to profit by experience. This leaves entirely out of account any consideration of the

---

[1] Wundt: Phys. Psyc., 1902, Bd. II, p. 332.
[2] *Loc. cit.*, p. 253.

subjective side of experience which we call consciousness. Under this definition the question of a divisible soul does not involve the question of a subjective spinal consciousness.

When soul is defined objectively as above it is open to experimental observation. The question is: Can a given organism profit by experience? In other words, can it learn? or in particular can the spinal frog learn? If it can we are justified in inferring that it has such a soul as has been described. If it has not it may fairly be regarded as a machine.

THE PROBLEM OF THE EMOTIONS.

By Gustav Spiller.

I.

The favorite theory of to-day concerning the nature of the emotions is probably that of Professors James and Lange, which claims, in Professor James's words, that "the genesis of an emotion is accounted for, as the arousal by an object of a lot of reflex acts which are forthwith felt" (*Principles of Psychology*, 1891, Vol. II, p. 454), or "that the bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur is the emotion" (*Ibid.*, p. 449). In the absence of these bodily changes, it is said, we should for instance, "see the bear, and judge it best to run, receive the insult and deem it right to strike, but we should not actually feel afraid or angry" (p. 450). Accordingly, the strength of the physical excitement, and that alone, measures the emotion. A rival theory is that of Prof. Irons who, especially in a recent volume, urges that an emotion is something "unanalysable and irreducible" (*A Study in the Psychology of Ethics*, 1903, p. 39), and that its essence lies in a feeling-attitude which has an outward direction, and deals with what is significant. An emotion, according to him, is a peculiar central reaction differing from pleasure-pain and from excitement, for while pleasure-pain is, he claims, passive and subjective, emotions are reactive. Similarly, excitement is not to be regarded as an invariable property of emotion; but here, unfortunately, Prof. Irons can only cite in his favor the emotions of 'cool' contempt, 'dry' admiration, and 'cold' dislike (*Ibid.*, p. 25), and one or two similar emotions, which leaves his case unconvincing, especially since it would be open for Prof. James to reply that 'cool' contempt is only cool when there is very little of it, or one might reason that these few apparent emotions are not to be regarded as true ones, considering, especially, that of the enormous number of so-called emotions only a very few can be claimed as being unaccompanied by excitement. Furthermore, is it quite correct to speak of joy, grief, and satisfaction as being generally or always reactive? All that apparently remains unchallenged of Prof. Irons's theory is, therefore, that in some sense, emotions form

a class which must not be confused with intellect, feeling, or will.

The simplicity and plausibility of Prof. James's theory make it attractive and recommend it; but one would like to feel more certain that his theory is based on a sufficiently exhaustive examination of the essential nature of the emotions on the cognitive and volitional side, and that it represents a successful attempt to define off emotion from what is not emotion, or satisfactorily determines the elements out of which an emotion as such is compounded.

There are several states which must be distinguished from emotional states. We have certain needs, such as hunger and thirst, which move us to action; but these represent impulses rather than emotions. So, too, through acting for a period along a certain line, with emotion or without, an inclination or organized tendency is gradually formed that brings about reactions which are otherwise not infrequently connected with emotional outbursts. Where such an inclination is, passingly or permanently, connected with more or less strong feeling, we speak of a sentiment or a passion rather than of an emotion. Diffused excitement may also exist without emotion. A person may be 'upset' by everything, the excitement continuing long after the occasion is past or remembered. Here we have a case of unstrung nerves or general mental irritability as distinct from pure emotion which is directly aroused by some definite circumstance and does not merely express absence of general equilibrium; perhaps we ought to speak in such a case of a secondary emotion, since the excitement aroused depends on a persisting excitement due to a preceding emotion. One form which excitement takes is that of hysteria, and here the absence of a definite end conclusively betokens the absence of emotion. We also speak of moods and temperaments, and these, too, cannot be called emotions, for they are diffused and are only minimally determined by outward circumstances. Cravings, desires, and bodily and mental pleasure-pains must likewise be excluded, though it is still to a large extent an open question how far these and other states enter into emotions or are confused with them. From the preceding it will be seen that we have not as yet even a recognized selective hypothesis as regards what states are to be termed emotions, for it is questionable, for instance, whether any diffused excitement or mood should be regarded as non-emotional. However, Prof. Irons's excellent analyses in Chapter III of his quoted work are well worth studying in this connection.

What, then, is an emotion? It might be said that if we combined Prof. Irons's "feeling-attitude" with Prof. James's "perception of bodily symptoms," which are said to mark an emo-

tion, we should have discovered the tantalizing secret of the emotions. On this hypothesis we should argue that somehow the thought that "certain circumstances are deplorable," and the connected or unconnected bodily excitement constitute together the emotion of grief, and that the absence of either of these argues the absence of that emotion. Yet in my case, and this is the burden of the present paper, introspection tends to show that these two together do not constitute an emotion, for we should only have a certain cold and colorless statement and an unconnected and unaccountable bodily excitement, and that is all. We must evidently go deeper. Everything which affects us or moves us is in some degree significant, *e. g.*, I put the pen down now because I want to think. Here there is no emotion—or shall we say an infinitesimal amount of emotion?—and in normal action, of which this is typical, emotion plays accordingly no traceable part. Let us, however, say that I have to decide whether, seeing that my life is in danger, I should stay or run. If I am unexcitable and high-principled, I deliberate unexcitedly about the matter and finally reach some conclusion as to how to act, so, if there is no time, I coolly fight for my life. Here we observe an outwardly directed and decidedly significant thought and no excitement or emotion, and yet in another individual the emotion of fear is induced very readily, even apart from exceptional significance. Similarly with bodily excitement. What physical signs are there to divide emotional from non-emotional states? The presence and the intensity of anger, of fear, and of rejoicing can be discovered and measured by the peculiarity of the physical excitement only after we are aware of the nature and the degree of the related cognitive and volitional excitement.

Now an analysis of an emotion as experienced, will, if the analysis be correct, give us some glimpses of the secret we are desiring to bring to the light. Not so long ago I was steering a boat for the first time, and as the small river, the river Charwell at Oxford, was crowded with boats, I was naturally anxious that no accident should happen through my inexperience. The emotion of anxiety was here fully developed, and I spent part of my time, whilst steering, in studying that emotion. The result of that examination was a view of the nature of the emotions which was new to me, for I had been an indifferent disciple of Prof. James. (Gustav Spiller, *The Mind of Man*, 1902, p. 271.) I noticed that I was in a state of perplexity. I could rest neither in hope nor in fear. I wanted to do more than one thing at a time. I was straining to know what to do. I wished to settle several difficulties at once, and hence a scurrying to and fro of ideas, most of which were scotched or killed before they had fully emerged. Here there was no serene

statement "I am perplexed as to what I shall do," and an unconnected or connected physical excitement; but there presented itself instead a crowd of incomplete thoughts hastening they knew not whither, and repeated and vain attempts were made at finding solutions. This state of mind, then, independently even of any bodily excitement, seems to be an emotional state. In other words, where there is no excitement directly aroused by a definite object or idea there is no emotion, and the greater the excitement the greater the emotion. At the same time the resulting bodily changes are at least frequently a substantial part of the emotion, for in acute anger and fear, where there is usually a reference to the taking of immediate action, it is clear that various physical adjustments similar in purpose to the cognitive and volitional adjustments above described—primarily muscular, and secondarily nervous and vascular—will be attempted. An angry man who would strike but restrains himself is physically very nearly in the condition of him who does strke. Or to take the case of my steering, it is evident that my muscular system was, in an incomplete way, as active as my brain. Indeed, the ordinarily accepted ideomotor theory implies that even the most ideal cognition which refers to action involves a partial carrying out of that action, and from this it follows that where the mental excitement referring to action is great, the physical excitement will be great also, and where the mental excitement is at its lowest there the physical excitement will be also at its lowest. So long, then, as the ideational content of an emotion has reference to the initiation of bodily action, so long is it impossible to regard the mental and physical excitement as separable or as independent; as well speak of an experimenter manipulating an instrument, and separate his thought from his action, without robbing both processes of their meaning. It is not a question of bodily excitement giving rise to mental excitement or mental excitement giving rise to bodily excitement, since they are both substantial parts of one act. Moreover, we have to remember that there is such a process as a mental reverberation complimentary to the physical reverberation, spoken of by Prof. James, for an important thought, or one in which we are immersed, or professional matter, ever comes uppermost, however strenuously we may endeavor to dismiss it; and likewise in an emotion, the mental reverberation, in accordance with this, lasts considerably beyond the initial moment of excitement, even after the basis for the excitement has been proved to be illusory. On Prof. James's theory, if I mistake not, the feelingless thought passes through the mind like a flash and there is an end to it; but in my emotional experience the problem suddenly raised by what provokes the emotion gives rise to a more or less tur-

bulent flow of thought which seeks, as in non-emotional experience, to meet the situation, and in proportion to the importance of the situation and the power of self-control there is produced a more or less orderly or chaotic mental condition. If only for the reason that Prof. James's theory does not seem to correspond faithfully to what we know of the normal workings of the human mind under the provocations which call out an emotional response, his theory does not appeal to the judgment as being readily defensible as regards its fundamental outlines. To this must be added that the power of suppressing certain emotions by inducing dissimilar bodily emotional attitudes, referred to by Prof. James, is paralleled by the well known fact that we can perhaps even more readily suppress emotions by turning our thoughts away into different or more desirable channels, and that certain classes of eccentricity and madness are consistent with the absence of any obvious emotional states. Our conclusion, then, must be that Prof. James is right in urging that physical excitement is present in emotion as an essential constituent; only we must hold that emotion also implies mental excitement, a more or less broken or hurried stream of thought tending to mental and bodily chaos when the excitement is great, and that these two series constitute properly only one series.

We have examined a pronounced form of the emotion of anxiety, a cousin to fear; but an analysis of any other emotion, say that of fear, will yield the same result. In unmistakable fear, for example, we are mentally overpowered; we try to think of ways of escape; we doubt whether we shall succeed; the thoughts hurry along wildly; we tend in many directions both as to thought and action; we are irresolute; we are in a highly strained condition as regards muscles and nerves, no sooner initiating movements than inhibiting them. Naturally, therefore, the body generally is thrown into a state of excitement, since muscles, nerves and blood vessels, as well as brain, are strongly affected, unless, indeed, the emotion is of a contemplative or minimal kind, though even here most probably we have no exception.

An emotion, of course, is not bound to find its expression in words, and close observation both of men and animals bears this out. To take a homely illustration from the farmyard, an escaped pig, vainly attempting to elude its pursuers when cornered in a chase, shows all the signs of fear which we might observe in a conscious human being, and the organized nature of all thought would point to the same conclusion. Sometimes, it is true, bodily excitement is out of proportion to the normal mental excitement (and *vice versa*); but here, owing to a morbid or other condition, the bodily excitement, and, indirectly

the mental, are over-emphasized and approach the stage of chaos. Where the emotion does not find its normal expression, there we speak accordingly of morbid fear or hope. However, it is quite within the range of possibility that now the bodily and now the mental excitement should be the more prominent.

This, then, seems to be the nature of an emotion. A certain more or less urgent need, aroused directly by some definite object or idea, is eagerly and yet vainly seeking to be satisfied. In so far as there is, as a consequence, mental excitement, a more or less turbulent endeavor to meet the situation in a satisfactory manner, so far the state becomes emotional, and the proportionate absence of this peculiar mental excitement argues the proportionate absence of an emotional coloring of new attitude. Such a definition excludes inclination, sentiment, passion, secondary emotions, mental and physical prostration and derangement, cool and deliberate judgment, habit, pleasure-pain, craving, desire, objectless excitement, temperament and moods, and seems to embrace nothing but pure emotional states and everything which characterizes these states. The definition likewise includes all pleasant emotional states such as rejoicing, for all emotions. like all pleasure-pain, argue a disturbance or absence of complete satisfaction. It explains also the origin in excitement of any and every attitude called an emotion and the necessary presence of physical excitement—even to the point of morbidity—when an emotion is observable, though it is somewhat difficult to reconcile this explanation with Prof. James's view which asserts that the perception itself, say that of a white sheet, immediately produces physical changes, the feeling or perception of which changes is supposed to be the emotion. Prof. Irons's 'cool' contempt also receives its explanation, for many attitudes are only minimally emotional and others are only by courtesy called emotionals. Besides, contempt may reach the stage of disgust, loathing and nausea, and be anything but free from excitement, while, on the other hand, our contemptuous attitude towards some one may merely imply that we have no very exalted opinion of him. In proportion as a state of mind becomes directly excited through a definite object or idea, so may we speak of the presence of emotion, and as the ideational stream takes different directions, so we speak of different emotions. Emotions, therefore, do not appear to be something unanalyzable, nor are they composed of a serene thought and pleasure-pain or bodily excitement; but in their essence they represent mental excitement produced directly through a definite object or idea, naturally combined with physical excitement, expressing the fused cognitive, volitional and active aspects. An emotion, consequently, is only a mental attitude in a state of excitement, and has no separate or independent existence.

II.

While there is no limit to the states called emotional, except that of general and almost infinitely varying interests, some of the emotions are yet well defined and discharge themselves along instinctive lines of activity or bring instinctive relief from unrest. Naturally, too, certain emotions are more fundamental than others, and those which are so, such as anger and fear, are common to most of the higher animals and their young and have their lines of development and discharge determined hereditarily.

The first thing we may learn, therefore, from an ethical standpoint is that emotions, or at all events pronounced emotions, are not indispensable in civilized life, for since an emotion represents but mental excitement, it lies within the range of possibility to avoid that excitement, *i. e.*, while desiring, thinking and acting are essential to life, *e. g.*, to the life even of the uncompromising Stoic, emotions are not equally indispensable. We may, therefore, ask the question how far emotions are ethically justifiable.

As to the master emotions their case is the most evident from a moral point of view. In animals generally, and also in the earlier stages of human development, it is essential that reaction should, as a rule, be instantaneous and appropriate, for the capacity for reflection exists then but to the slightest degree and adaptations of a far-reaching kind are, therefore, impossible, especially considering that adjustments relating to the far future are inappropriate and useless in a primitive environment. Certain practical attitudes, associated namely with marked excitement, anger, fear, revenge, jealousy, are accordingly developed to protect the primitive individual automatically. The place of reflection is here occupied by an inherited reflex mechanism, and though the consequent reactions of such a mechanism would be necessarily inappropriate in the extreme within a complex society, they suffice for primitive beings primitively placed. With high mental development the readily acting reflex mechanism does not disappear; but the need for it has almost passed. The civilized person's relation to the world around him is complicated, and owing also to his being a part of a highly evolved community, he has no need to react quasi-mechanically. He may allow trained impulses to do thoroughly what fitful anger, fear or jealousy would otherwise most imperfectly accomplish. When, for instance, some one is wronged, instead of being angry, he may address himself to some appropriate impulse in his would-be enemy, calmly prevent him from acting unrighteously, or appeal to the law.

A highly advanced being adjusts his actions in accordance

with a general ideal, that is, in accommodating himself to the present, he takes into account the future. His aim is not to deal out rough justice, but strict justice. Excitement, he knows, generally emphasizes the needs of the moment at the expense of those of futurity, and accordingly he is averse to acting when in anger or in passion, unless he has first weighed the matter. An emotion suggests, as Bain has pointed out, a more or less self centred idea, and tends, as a consequence, to interpret everything from its own point of view. The advanced ethical man, therefore, will proceed, prompted by powerful and trained sentiments which have primarily respect for universal well-being, and will not act on the basis of sudden emotions, except of such as have been aroused as the result of examining a case in a judicial spirit.

To live according to broad principles is the tendency of highly developed beings. This implies that we ought not to be governed by suddenly upwelling emotions, but rather by sentiments of a most comprehensive type, and that without anger, fear, indignation, hatred, contempt, disdain, envy, jealousy, malice, pride, arrogance and shame, one may pass an eminently innocent and useful life. The judge may be just and severe in his judgments without in any way being either unemotional or unduly influenced by emotions out of accord with the general justice of the case. Our sense of right and truth, our systematized conception of life, our respect for all sides of our nature and for the common good, the inclination towards living a consistent life, and broad-based sentiments, are guides which replace rather than supplement the primitive emotions.

Like and dislike, delight and sorrow, love of truth, justice and beauty, might be said to be the minimum for man in the way of emotions, if, indeed, any of these here named can be regarded as emotions, for the first few are perhaps pleasure-pain attitudes, and the latter perhaps only refers to sentiments or inclinations. We are, for instance, glad that our son is a good scholar (without being proud of him), that a certain person is near us (without loving him), and that we are able to protect ourselves (without being revengeful). We can dispense with by far the greater number of emotions and sentiments.

Though many emotions, and especially the primitive ones, become superfluous or of little account with social advance, yet it appears difficult to imagine that men, however advanced, should not *pity* him who suffers, or that we should not warmly *love* our offspring. It is well to remember that the only thinkable and defensible ground on which men can agree for opposing a course of thought or action is its incompatibility with the total individual and social life, and that any other standard

demolishes itself. Consequently, in so far as an emotion or indeed any practical attitude deleteriously affects life as a whole, so far is it to be suppressed, while when an emotion proves to be helpful, its cultivation is morally imperative. The abrupt, irresponsible, blinding emotions, such as rage or terror, may be safely discouraged, for the love of a comprehensive ideal can replace them; but the tender emotions, such as sympathy, pity, and kindliness, need only be guarded against when they tend to become unjust to life as an organized complex. The advanced ethical man, if this be true, will be endowed with emotions; but he will not permit them by their impulsiveness to endanger or nullify the rights of the other parts of his nature. Indeed, heartiness and boisterousness are probably more satisfying and argue a richer and robuster nature than stiffness and immovability, and, therefore, ethically speaking, we ought not to aim at the total suppression of the emotions, but rather at limiting them to their legitimate sphere of influence. Absence of impulse, desire and emotion do not accordingly distinguish our ideal of a man; for he who only acts from a sense of duty and has no love for his kind stirring in his breast, is scarcely a human being at all, leaving aside the implied neglect of the additional stimulus to right conduct which, as Bishop Butler has pointed out, is supplied by the affections.

Again, if we are to lead a useful life, mental excitement cannot be avoided altogether, for sometimes we have to decide hurriedly between alternatives, *e. g.*, as to whether we are to catch the train now about to depart or go by some later one, in which case there is no room for calm deliberation, and especially is this so since we must recognize an emotional state even when the perturbation is very feeble.

Many of the so-called emotions are really not emotions at all, though the precise border between excitement and absence of excitement is as difficult to ascertain as the frontier between excitement and mental and physical confusion or prostration. We sometimes say "I *fear* he will come," "I am *sorry* for him," "I *pity* his lot," "I *dislike* him," "I am *angry* and *indignant*," when we mean "I have reason to think that evil will result from his coming," "I should have saved him trouble if it had been in my power," "I would improve his lot if I could," "I am not attracted by him," "I am not favorably impressed." In these instances there is but the veriest atom of excitement, and thus, with ethical advance, the vocabulary of emotion is deprived of a large part of its meaning and becomes almost wholly metaphorical, that is most of the emotions lose nearly all their intensity. If the Stoic, as Marcus Aurelius Antoninus describes him, or the Cynic, as Epictetus draws him, represents the most advanced ethical type, then the ideal man is

ever serene and gentle, and never unjust by reason of his emotions. Such, too, has been "the ideal of ancient sages," for Confucius, Buddha, Socrates, Jesus, Marcus Aurelius, all typify serenity, and the phrase "an excitable saint" approaches to a contradiction in terms. And yet it is difficult to determine the golden mean which shall do justice to human nature as such. Is it not rather that, instead of being coldly intellectual, the advanced ethical man is full of fire and vivacity, and that he only differs from those who rank below him in never having evil or superfluous emotions such as rage or pride, and that his emotions never make him act unfairly to himself or to his fellows? The above view follows that of Prof. James, who says that a non-emotional existence, "although it seems to have been the ideal of ancient sages, is too apathetic to be keenly sought after by those born after the revival of the worship of sensibility, a few generations ago" (p. 453). Modern ethics will have nothing to do with an ascetic view of life or a pessimistic theory of human nature. Let the petty emotions and the mischievous ones and most of the primitive ones go or be applied only under primitive conditions; let the gentle emotions, the useful ones and the great ones be encouraged; and let the emotions have no unsettling influence over our conception of life as a consistent unity. The result will be a being completely capable of self-control and never requiring much of such control, gentle in manner, self-possessed, stern when necessary, and bubbling over with the joy of life and action. Such a being would be free from pride, arrogance, humility, envy, jealousy, ambitiousness, anger, hatred, scorn, contempt, and all the related brood of semi-civilized and petty emotional states, sentiments, and practical attitudes. His heart, on the contrary, would overflow with sociability and pity, with a warm desire for doing justice and defeating injustice, and with a love of truth, beauty, goodness and nature.

III.

On the psychological side the conclusions arrived at in this paper as regards the nature of the emotions are far from claiming that they close or exhaust the inquiry. While insisting that physical together with cognitive and volitional excitement, directly induced by some definite object or idea, appear as invariable concomitants in an emotion and that an emotion is a mental attitude in a state of excitement, we have left undefined the problem of the exact nature of the excitement, as in anger and fear, in rejoicing and grieving. The term excitement, in other words, but vaguely hints at the passive factors involved in an emotion which tends, in the one direction, to a cold inclination, and, in the other, to mental and physical

chaos. Secondly, we have attempted, by the method of exclusion, to separate strictly emotional from non-emotional states, and we excluded, on the ground of absence of excitement directly aroused by a definite object or idea, Inclination, Habit, Sentiment, Passion, Secondary Emotions, Temperament, Mood, Diffused Excitement, Desire, Craving and Impulse. Still, the enormous number of so-called emotions, bewildering in their variety and relationships, requires to be explained and to be reduced to order, and, as Prof. Irons well shows in the volume alluded to, the list of the emotions demands to be reconstructed. Here we can only suggest that since the circumstances which arouse emotions give rise to an infinite variety of ways of grappling with them, there is no limit to the possible variety in emotions and classes of emotions. To this must be added that the emotions as they were conceived of before the era of scientific analysis, are largely misinterpreted through the almost invariable presence in them of countless non-emotional elements. Perhaps, too, most states, if not all, have an emotional aspect, and are as yet not recognized as such because the excitement is relatively feeble and is, therefore, overlooked. Suffice it to have drawn attention to the importance of doing greater justice to the careful analysis of the cognitive and volitional elements in emotions as they are experienced. It may be, after all, that not until the more general truths of normal psychology are well established, shall we be quite clear as to what is and what is not to be included in emotional states and what are their fundamental characteristics. Perhaps we shall find then to our surprise, as we have already endeavored to show, that there are strictly speaking no emotions, and that what we call emotions are directly aroused attitudes in a state of excitement. We should, on this principle, understand at once the great multiplicity of the so-called emotions and the variety of explanations concerning them.

The problem does not seem so complicated on the ethical side. That the primitive emotions, such as anger and fear, partake of the nature of instincts is as evident as that with the growth of civilization the violence, the reflex character, and the imperial sway of these emotions are steadily discouraged, and that in the end there remain a few master sentiments, appropriate to the new conditions—sociability, respect for self and others, pity, and love of doing justice to the whole nature of man. We recognize here three stages: the primary and instinctive one, where there are a few headstrong emotions which only take directly into account the good of the moment; a transitional and semi-anarchic period, where an army of emotional and other attitudes, such as pride, ambition, contempt, shame, conceit and love of glory develop; and a final and or-

dered stage, where a few impulses, principles, emotions and more especially sentiments of a comprehensive character, harmoniously seek to do justice to the individual, to society, and to nature, as an interdependent whole. The intellectualist who dreams of a golden age when men will despise emotions and sentiments and be wholly guided by reason, meets with no support from the above analysis; nor does the moralist find favor who exalts the sense of duty and the possession of principles and despises the affections and the joy of life; nor again are those encouraged who plead for the so-called artistic temperament which would perpetuate the present stage of rule by innumerable petty emotions. Speaking generally, primitive virility, if one may prophesy, will remain, while a few broad-based and powerful sentiments will take the place of the few imperious emotions which dominate primitive life.

A SIMPLE COMPLICATION PENDULUM FOR QUALITATIVE WORK.

H. C. STEVENS, Cornell University.

An experiment is described in Titchener's Laboratory Manual, i. S. M., 115, to demonstrate the law of attention that "the process attended to rises more quickly than other processes which enter consciousness simultaneously with it." The apparatus required is a bell metronome. The two simultaneous stimuli are the click of the metronome and the sound of the bell.

Under favorable conditions, the experiment may be successfully performed. The observer, by attending mainly to the click or mainly to the bell, is able to alter the apparent temporal relation of the two impressions. There are, however, two general objections to the method. In the first place, the fact that the two impressions belong to the same sense department is a real difficulty for novices,—sometimes even for experienced observers who have not had special practice. A second objection is that the succession of clicks and tones tends to fall into a subjective rhythm, in which now the noise and now the bell-sound may be accented. This accentuation gives the accented member of the series a greater hold over the attention, so that the verification of the law may be helped or hindered in a way not allowed for by the experiment.

A simple device for the simultaneous presentation of two impressions from different sense departments can be made with a bell metronome and a piece of cardboard. The cardboard is cut in the form of an arc of a circle whose radius is the length of the metronome pendulum. Scale divisions of 5° are laid off on the circumference. The cardboard arc, with the 0° of the scale corresponding to the position of equilibrium of the pendulum, is impaled on the eye which serves to lock the lid of the metronome. In this position, the white cardboard, bearing its scale, forms a background, in front of which the pendulum oscillates. A piece of red paper, cut in the shape of an arrow-head, may be spitted on the pendulum to make its movements more conspicuous. The metronome should be set to beat about 72 times in the 1 min. with the bell ringing at every complete oscillation of the pendulum. One has, by this arrangement, the simultaneous presentation of a visual and an auditory impression. The position of objective coincidence can be found, approximately, by slowly moving the pendulum with the hand, until the bell sounds. With this apparatus the experiment is performed by directing the attention, in the one case, mainly to the red arrow-head, and, in the other, mainly to the bell, the experimenter reading off from the scale the position of the arrow in each case. Objective simultaneity, for the metronome used in the Cornell Laboratory, came at 22°. When I attended mainly to the arrow, the bell seemed to ring at 30°; when I attended mainly to the bell, the arrow was between 10° and 15°. Similar results were obtained by other observers.

This experiment, of course, inverts the conditions of the 'complication experiment,' in which nothing is said about the voluntary shift of attention. But inasmuch as the rate of the metronome pendulum can be varied, the apparatus could be used for qualitative complication work.

LITERATURE.

PSYCHIATRY.

By Dr. I. H. Coriat.

SOME RECENT LITERATURE ON TRAUMATIC INSANITY.

The growing need for the determination of exact etiological factors in the production of various mental disorders, has been the impetus for the recent literature and observations on traumatic insanity. These psychoses are polymorphous in type and comprise delirious and dreamy states, various vaso-motor disturbances, irritability with special intolerance for alcohol, peculiar amnesias and marked memory disorders, deterioration, marked tendency to fabrications, paranoic and katatonic states; or the trauma may be a contributory factor in the production of other so-called organic and functional psychoses, which we are in the habit of looking upon as having a different etiology. Viedenz (Ueber psychische Störungen nach Schädelverletzungen, Archiv für Psychiatrie, Bb. 36, 1903) reports four cases, and concludes that mental disorders following trauma are protean in type, but have the following common traits, viz.: change of character, excitability, diminution of memory and intolerance for alcohol. The most frequent psychoses are primary dementia, katatonia, and confusional and stuporous states. Paranoia is rare. The first case relates to that of a soldier, in whom, following a fall from a horse, there arose a state of apathetic dementia. In the second case the patient became excited after a fall from a tree, and then there supervened a katatonic complex, with catalepsy, negativism and convulsions. The third observation is that of a boy, at 14, whose grandfather died of alcoholic insanity. Following a fall on the occiput, there developed attacks of ambulatory automatism. In the fourth case, trauma was probably only an exciting factor. A general, at 40, fell from a horse, and three months after the accident there developed symptoms of general paralysis, with speech disorder and repeated apoplectiform attacks. Death ensued after fourteen months and the anatomical picture bore out the clinical diagnosis.

Kalberlah (Ueber die Acute Commotionspsychose, zugleich ein Beitrag zur Aetiologie des Korsakow'schen Symptomencomplexes—Archiv für Psychiatrie—Bb. 38, H. 2, 1904) contributes an important paper showing the immediate bearing of trauma on Korsakow's symptom-complex. The symptoms described by the Russian psychiatrist, as being practically a clinical entity and occurring almost wholly in the subjects of chronic alcoholism, and almost invariably associated with neuritis, have during later years been found to accompany a multitude of other conditions. It may occur in chronic alcoholics with or without neuritis ("polyneuritic mental disorder"—Cole), in acute melancholia with anthrax infection (Soukhanoff and Tscheltzoff), following pelvic abscesses from extra uterine pregnancy, in delirium tremens, presbyophrenia, in cases with unknown etiology without neuritis, in chronic lead intoxication and cerebral syphilis, in general paralysis and following infection and strangulation. Meyer and

Raecke (Zur Lehre von Korsakow'schen Symptomen-Complex—Archiv für Psychiatrie, Bb. 37, 1903) have recently reported the symptom as occurring in three alcoholic cases without neuritis, one senile case with gross vascular lesions, and in one case of sarcoma of the frontal lobe.

Considering the multiple etiological factors concerned in the production of this symptom-complex, a paper like Kalberlah's, in which the clinical history of even one case, is reported in great detail, is of exceptional value, for the greater part of mental disturbances following trauma are of a slow development, and are usually given meagre detail in connection with medico-legal complications. Kaplan's "traumatic degeneration of character, an explosive diathesis," merely relates to the impulsive acts and insidious changes of character in these patients. According to Kalberlah, there may be marked mental enfeeblement, lessened memory capacity for the reproduction of recent impressions (Merkfähigkeit), disorders of attention (Aufmerksamkeit), perception and judgment, a variable emotional condition and increasing apathy. There may also follow transitory unconscious states and various motor, sensory and vaso-motor disorders. He finds all the elements of the traumatic psychosis in chronic alcoholism, and calls the mental symptoms immediately following injury "the acute psychosis of commotion." The cases which he studies are given in great detail. The first case was that of a mason, 43 years of age, non-alcoholic. In ascending a frail ladder, the structure broke, and he was thrown to the ground, a distance of five meters, striking his head on a stone. He bled profusely and was picked up unconscious. In the second case, there was a fall from the height of four meters, the injury being to the head. The first case showed focal symptoms in the shape of a double facial paralysis, and in both the typical Korsakow's psychosis developed; disorder of attention, euphoria, absence of hallucinations and of any fixed delusions, and a prominent defect of orientation. The memory was particularly affected, there being amnesia, a persistence of old memories and a marked enfeeblement for recent memory impressions.

E. Meyer's contribution (Korsakow'sche, Symptomencomplex nach Gehirnerschütterung; Neurologisches Centralblatt—Bb. 23, N. 2, 15. Aug. 1, 1904) relates to the case of a fireman, aet. 32, with a negative history of alcohol, heredity and infection, who suffered a severe injury of the skull, with probably a fracture of the base. This was followed by coma; then there supervened a state of agitation and deep disorientation, with a high grade memory defect for recent impressions, fabrications and amnesia for the accident. There was no ataxia or neuritic pains, the knee-jerks were always present, but there was severe headache and dizziness. Later there occurred two epileptic seizures. An operation revealed nothing and no improvement followed. The mental picture in every way resembled Korsakow's symptom-complex. The paper gives a comparative table of the patient's reaction to the same series of questions at different intervals, in order to show the contradictory replies, the result of disorientation and the memory disorder.

Amongst our clinical material we have seen a case in many respects similar to those above. The patient was a weaver, moderately alcoholic, who fell from an upper story balcony, striking on his head. He was picked up unconscious and in what was thought to be a dying condition. There was deviation of both eyeballs to the right, but no bleeding from the ears or nose. On regaining consciousness, there was marked confusion, disorientation, dizziness especially on turning quickly, deviation of tongue to the left, impairment of smell

in both nostrils, marked memory defect for recent events and impressions, rather prominent florid fabrications, and amnesia for the accident, but nothing of the retrograde or retroactive type.

Dr. Adolf Meyer's paper (American Journal of Insanity, January, 1904) relates to a larger clinical material than any of the previous contributions. In all, 31 cases are reported, and the histories show how multiple may be the psychic symptoms following trauma. The literature and the various theories relating to the exact bearing of trauma on mental disturbance, are reviewed. He suggests that in this group of cases there are at least five directions in which clinical studies may be of value.

1. Rieger's attempt at an inventory of the patient's mental possibilities.
2. The study of the vaso-motor neurosis of Friedmann.
3. The examination for the "explosive diathesis" of Kaplan.
4. The occurrence of dazed and dreamy states, conditions of anxiety, epileptic seizures.
5. The establishment of the etiological factors.

The prominent types in the classification are suggested as follows: the direct post-traumatic delirious states, the post-traumatic constitution, the traumatic defective conditions, traumatic psychoses from injury not directly affecting the head, and psychoses in which trauma is merely a contributory factor, such as general paralysis, manic-depressive insanity, and katatonic and paranoic states.

Archives of Neurology from the Pathological Laboratory of the London County Asylums. Edited by F. W. Mott, Vol. II, 1903. Macmillan & Co.

This is the second annual publication of the work of the pathological laboratory of the London County Asylums, edited by Dr. F. W. Mott. It is twice as voluminous as the publication of the previous year, and a glance at the titles shows how valuable are the works of Dr. Mott and his associates in the domain of neurology and psychiatry. The first and most voluminous paper, comprising 327 pages, on "Tabes in Asylum and Hospital Practice" is from the pen of the editor, and it is certainly the most complete and masterly exposition of the subject which we have met. The paper is especially strong on the physical symptoms of tabes, including minute studies of the sensory disturbances, and of the morbid anatomy and pathology of the disease. The clinical material is large, comprising in all seventy-four cases, but it is unfortunate that the mental states accompanying tabes and tabo-paralysis are not given in more detail, considering the excellence of the status of the physical conditions and the anatomical findings. Dr. Mott takes a strong stand regarding the syphilitic origin, if not nature, of tabes, general paralysis and the combined types of the disease, and this is in harmony with our modern conceptions in spite of a few weak arguments to the contrary. His words are worth quoting and most convincing. "That we cannot prove more than 70 or 80 per cent. of tabic and paralytic patients to have suffered with syphilis, is no argument against the doctrine that both paralysis and tabes are post-syphilitic affections. . . . In sixty cases of syphilitic brain disease I could not obtain a history in more than 70 or 80 per cent. The very important experiments of Jadassohn and Hirschl, that only in one-half of the cases of undoubted severe syphilis is it possible to prove primary infection, and the statement of Lang that in one-third of the cases of tertiary syphilis the primary infection was not demonstrable, are arguments against those who will not be convinced that syphilis is the essential cause of tabes and general paralysis unless it can be proved in every case."

He divides his cases into six groups as follows:

1st group—Those cases of tabes which present some unusual clinical phenomenon, or are adapted for explanation of some essential feature of the disease.

2nd group—Cases of tabes with insanity, not essentially the combined form with general paralysis, but with any fundamental psychosis, usually of the nature of an acute hallucinosis.

3rd group—Tabo-paralysis.

4th group—Tabo-paralysis with marked speech affection.

5th group—Optic atrophy and Tabo-paralysis.

6th group—Conjugal Tabes and Paralysis.

The next three papers discuss at length "Amentia" (Idiocy and imbecility) by A. F. Tredgold, the "Histological Basis of Amentia and Dementia" by Joseph Shaw Bolton, and the "Pathology and Morbid Anatomy of Juvenile General Paralysis" by George A. Watson. The papers deal in so minute a detail of the various subjects of which they treat, that only meagre justice could be done them in the limits imposed by a review. "The Prevention of Dysentery in the London County Asylums" by Dr. Mott, is a paper giving practical suggestions on the clinical symptoms of the different types of the disease, its prevention, its bacteriology and morbid anatomy.

There are two contributions on nerve chemistry, one by Halliburton and Mott on the coagulation temperature of cell globulin and its bearing on hyperpyrexia, the other upon the cholin test for active degeneration in the central nervous system. The first paper details a series of experiments on cats and on human brain material confirming the hypothesis that the physico-chemical cause of death from hyperpyrexia is due to the coagulation of the cell globulin; and anatomically this is coincident with the chromatolytic changes in the nerve cells. The paper on cholin gives a modification of Halliburton's recent method, but here it is applied to human blood and not to cerebrospinal fluid. The presence of the cholin crystals in the form of the double platinum salt, is a measure of myelin degeneration, but the test is useless to determine whether a cause is organic or functioned, unless the organic disease is active at the time the blood is drawn.

Smith's paper is a psychopathological study of the range of immediate association and memory in normal and pathological individuals. The importance of testing patients subject to mental disease in regard to their power of acquiring new impressions and ideas, and in their capacity for reproducing the same has been greatly emphasized of late, especially by Kraepelin and his pupils in their publications in the Psychologische Arbeiten. The tests were done orally, and uniformity in the presentation of the series was secured by means of the metronome, the pronunciation of each letter being made to coincide with a beat of the instrument. As the result of a large series of experiments, he draws the following conclusions: The method of immediate oral reproduction of auditory impressions appears to be reliable and practicable both with normal and pathological individuals, and to be well fitted to test the range and character of immediate association in different mental states. He divides these cases into three pathological groups: (1) three men in the early stages of general paralysis; (2) general paralysis in three men and one woman but the disease is less marked than in the first group. The male cases had coincident tabes and there was a history of alcoholic excesses; (3) three women and two men presenting general features of some degree of dementia, confusion and loss of memory, with a history of previous marked alcoholism. With normal subjects the range of immediate memory has usually a definite limit which varies with each individual, but as a

rule is found to lie at five letters. When the limit is reached the addition of one letter to the series of auditory impressions produces a very decided fall in the number of series which are reproduced quite correctly, this fall amounts to 40 to 50 per cent. on the average. With abnormal subjects the relations are similar but less clear. In the abnormal cases the general nature of the pathological changes are similar. They consist in a marked diminution in the power of reproducing impressions in correct order, and in a more or less distinct increase of all the errors indicating the more severe forms of associational disorder. In all the groups (normal and abnormal) within certain limits the total of errors indicating partial dissociation or disorder remains relatively constant and reaches approximately the same absolute magnitude. None of the groups shows any marked fluctuations of attention, or any distinct and regular improvement by practice. With the help of this method we are able to differentiate with some precision between the more permanent memory and the power of immediate reproduction.

Bolton's paper on the "Pathological Changes in the Medulla Oblongata in Acute Diphtheritic Toxæmia" is a study of the degenerative changes caused by the diphtheria toxine in the nuclei of the medulla. The contribution by Cole is a further histological study of one of the three cases published in Brain (Autumn, 1902), relating to changes in the central nervous system in alcoholic paralysis with the characteristic polyneuritic mental disorder.

A Case of Moral Insanity with Repeated Homicides and Incendiarism and Late Development of Illusions. H. R. STEDMAN. Boston Medical and Surgical Journal, July 21, 1904. Vol. CLI, No. 13.

This very excellent contribution relates to the case of the moral imbecil, J. T., who suddenly became notorious as one of the greatest poisoners of modern times. The entire history is given in great detail showing the gradual development of the moral weakness, the repeated homicides by poison, the medico-legal complications and the metal status of her hospital residence with the elaboration into a fixed, delusional state. There follows a discussion of the case by members of the medical society before whom the paper was read. On the whole, it is an important contribution to the much-discussed subject of moral insanity and it will certainly repay perusal.

The Localizing Diagnostic Significance of so-called Hemianopic Hallucinations with Remarks on Bitemporal Scintillating Scotomata. A. PICK. American Journal of the Medical Sciences. Jan., 1904. Vol. CXXVII, No. 1.

Recently Prof. A. Pick, of Prague, has made several contributions to American and English Medical Journals, and the one whose title appears above is probably the most important, combining as it does localizing neurological diagnosis, with the most prominent symptom occurring in the course of mental diseases. He bases his paper on a recent observation of Jolly, that light phenomena in a hemianopic field of vision, have their origin in the primary optical tracts and not in the cortex. He elaborates on this statement, however, by showing that more complicated phenomena than simple, elementary light sensations, in fact, real hallucinations, may be produced in an hemianopic area by focal organic or functional disorders in the optic tracts. Four cases are given, mostly from the author's private practice. In regard to visual hallucinations in general, it is now known that they may take place in any part of the visual apparatus, from the cornea to the cortical layer in the occipital lobe, and the author promulgates a

similar theory regarding hemianopic hallucinations. With these latter there usually coexists other focal symptoms, such a paraphasia, paragraphia, hemianæsthesia, etc. He argues against the functional nature of the disturbance, basing his theory on the clinical material at hand. These hallucinations may be mere light phantasms, color disorders with changing of colors, animals, vague figures and phantoms, colored lights and planes, and lines and figures moving in snake-like gyrations. Sometimes the figures are sharply defined, at others they may present a hazy "fringe."

Ueber Ermüdungskurven bei Gesunden, Neurosen und Psychosen. DR. BREUKINK. Monat. f. Psychiatrie und Neurologie. Bd. XV. H. 4, April, 1904.

The work was done in the psychological laboratory of the psychiatrical clinics of Utrecht and Halle. The ergograph of Kraepelin was used with weights of 5, 4 and 3 kilograms. The lifting was carried on to exhaustion with a pause of two minutes between each series of curves, and the rhythm was registered by the metronome. In the illustrations the following ergograms are given: hysteria without any particular motor symptoms, neurasthenia, multiple sclerosis with one-sided hemi-paresis (the curve being taken with the left hand), chorea minor almost entirely confined to the left side with a curve of a permanent contraction in the same patient, and two curves from a case of dystrophia muscularis progressiva. The author draws the following conclusions. In healthy individuals there is ordinarily found a high convexity in the commencement of the curve. In many cases of hysteria, which psychically showed only the well known psychopathic constitution, there is often found a remarkable giving out which soon passes away, so that in these cases, after the pause of two minutes there may be the same or even a greater number of liftings than before the pause. In most cases of neurasthesia, the course of the height of the exhaustion curve was straight or concave. In chorae the involuntary contraction soon strengthened, but then weakened, so that the curve had a very irregular fall. The retardation of the fatigue was also remarkable. In cases of organic cerebral hemi-paresis (multiple sclerosis, brain thrombosis, general paralysis) the number of the liftings and the mechanical work of the paralyzed side is less, while the average lift height is about the same as on the healthy side. In a case of dystrophia muscularis progressiva, it was observed on the contrary that with a small average lift height, the number of liftings was disproportionately large.

[For further applications of the ergograph to psychiatry see "Ueber die Wirkung der Theebestandtheile auf körperliche und geistige Arbeit," by A. Hoch and F. Kraepelin, Psychologische Arbeiten, Bb. I, H. 2 and 3, where it is applied to the mental and physical effects of caffein and the ethereal oils of tea; also "On Certain Studies with the Ergograph," by A. Hoch, Journal of Nervous and Mental Diseases, Vol. XXVIII, p. 620, 1902, where there are given graphic studies of retardation and inhibition on the voluntary motor processes in the depressed phase of manic-depressive insanity, and finally the same writer's review of psychological and physiological experiments done in connection with mental diseases, Psychological Bulletin, Vol. I, Nos. 7-8, June 15, 1904.]

Vergleichende Psychiatrie. F. KRAEPELIN. Centralblatt für Nervenheilkunde und Psychiatrie. Bb. XV. July, 1904.

This highly suggestive paper, is we believe, the first serious contribution to comparative psychiatry. The observations were made in the

insane asylum of Buitenzorg in Java, under the direction of Dr. Hoffman. It discusses the important question, whether individual and racial peculiarities and habits, as well as the sociological status of patients, have any visible bearing upon their mental disturbances. In the study of the cases, we must look, not upon a temporary symptom-complex, but upon the complete disease picture from its earliest development and along the entire line of its evolution. There were no cases of alcoholism in the native born, while fifty Europeans in the asylum were strongly alcoholic. Opium delirium is seldom seen among the Chinese, while malarial psychoses are quite rare. Epilepsy occurred eight times among the native born, and twice in Europeans. In 370 native patients there was not one case of general paralysis or brain syphilis, whereas among the fifty Europeans in the same asylum there were eight cases of general paralysis. Dementia præcox was more prevalent among the natives, but the course of katatonia, when it occurred was very mild. Manic-depressive insanity was seldom met with, and its different phases were less prominent than among Europeans. Delusions when present were weak and almost never systematized, while auditory hallucinations were rare, this probably being due to the fact that thinking was carried on without the aid of auditory images.

The two diseases most prevalent among the Malays are Amok and Látah. The latter, which is probably not a clinical entity, shows automatisms with coprolalia and clouding of the consciousness. Many of its manifestations are hysteriform in nature, whereas the blind fury of Amok seems to be related on the one hand to katatonia, and on the other to psychic epilepsy.

[Both folk psychology and comparative psychiatry in connection with individual and racial peculiarities are becoming of great importance in the study of mental disturbances. Among the more primitive peoples, with an undeveloped and non-flexible language, it would be interesting to note how far sound associations enter into the productions of the manic phases of manic-depressive insanity. Also the modern developments of science would seem to furnish a fruitful field for the study of the genesis and content of hallucinations and delusions, and especially the frequent explanation of the latter as being based on electrical influence or telephonic or phonographic communication. Negroes seem especially prone to a blind, religious exaltation, both as individuals and by psychic contagion in their revivals and camp meetings. This exaltation may comprise the entire mental disturbance, or it may be merely an episode in a fundamental psychosis. In katatonia in Russian Hebrews, the religious coloring is derived from Old Testament conceptions of Jehovah or from later rabbinical lore and superstitions. Refusal of food among them has often a religious and not a delusional basis. The few Chinese patients that we have observed, have shown religious ideas that were at once a combination of Christianity and the teachings of Confucianism. The native language of patients has frequently a great influence in the production of their auditory hallucinations, for, in English speaking patients of foreign birth, the imaginary voices are nearly always in their mother tongue. Urban districts are almost entirely free from syphilis and consequently from general paralysis. The occurrence of pellagrous insanity in Italy and of hasheesh delirium in Egypt and India are also well known examples, while the long continued solitary meditation of the mediæval mystics, with the irbeatific visions, and of the Hindoo priests may also have a bearing on the production of certain psychoses, if indeed they are not the mental disturbances themselves.]

Les Obsessions et la Psychasthenie. Vol. I, par Pierre Janet; Vol. II, par Pierre Janet et F. Raymond. Paris, Felix Alcan, 1903.

This recent monumental work of Janet offers interesting and valuable problems to the psychologist, psychiatrist and general student of medicine. H. N. Gardiner, of Smith College, has given a critical review from the standpoint of pure psychology, and it seems opportune at the present moment that an analysis be forthcoming according to the tenets of psychiatry, for the work deals so exclusively with the borderland cases of mental disturbance. The psychasthenias are related on the one hand to the broad clinical complexes of hysteria and epilepsy and on the other to the fundamental psychoses. This type of borderland case is of increasing and paramount interest to the alienist, and a study so complete as is contained in these volumes, will bring forth points that will serve to more clearly elucidate these important problems. The second of these volumes is written in conjunction with Prof. Raymond, and in all there are extended clinical records of 236 cases, comprising the entire range of obsessions, impulses, mental manias, folies, tics, agitations, phobias and algias, the different délires, the conditions of anxiety and distress, feelings of inadequacy, the peculiar feelings of strangeness and depersonalization, and the neurasthenic states, all of which have fundamental characteristics and are grouped under the title of psychasthenias. The analytical details relate principally to symptomatology and the evolution of the disease-processes.

Out of his clinical material, the author selects five cases, which he has studied with great care and detail. The other cases are grouped around these five which serve as types. These five cases, which must be read carefully before the text can be fully comprehended, are case 222, Obsessions of sacrilege and of disgrace of body, with erotic hallucinations, tic des efforts and feeling of incompleteness. Case 223, Obsession of contract with the devil, with numbness and feeling of inadequacy. Case 157, Hypochondriacal obsessions, masturbation, phobias, symbolic hallucinations, Case 166, Délire de maigreur in reaction to ideas of disgrace of the body, aboulia, crises of agitation and refusal of food. Case 171, Crises of sleep, feelings of inadequacy, disgrace of self, gastric atony, arthritis.

The first group to which the author turns his attention are the obsessions. These are intellectual phenomena of the highest order, an idea, and often, an idea which is very abstract and complicated. They are distinguished by their absence of usefulness in practical life; in fact, they are pathological and not normal ideas. They are divided into five classes; obsessions of sacrilege, crime, disgrace of body, disgrace of self and hypochondriacal ideas. These again have numerous subdivisions which are taken up in detail. In spite of their variation and multiplicity of symptoms, this group has common characteristics; thought is always directed to bad behavior, it relates to objects of the external world, to the feelings, or to the body of the patient himself. Extremes of behavior and reaction are always reached. There is always a strong tendency to action, but a very marked absence of execution, yet certain patients will perform acts having some relation to the obsessions, or even contrary acts may be the result of the dominating idea. In these obsessions the idea is stronger than the motor impulse, in other words there is always a coincident weakness of will. As these states endure for years and are unaffected by any method of treatment, by psychotheraphy or otherwise, the condition of these patients is truly pitiful, for the permanent fixation of their ideas is very prominent and interferes with all their habits of daily life. The associated hallucinations are always vague, the visual image seems to be without

color and the words without sound; they have not the characteristic of exteriority, they lack reality, they are merely symbolic of the dominating idea. Even when these patients exert the stronger will power to keep away from these obsessions, yet frequently by the association of ideas, it is brought irresistibly back to them.

These obsessed patients show other phenomena, for, without any determinant idea, they are forced to think in an exaggerated manner, their head "works" in spite of them, they feel compelled to accomplish useless movements and have violent, irresistible emotions. These ideas may exist without any obsessions and they then constitute a group of symptoms more simple than the obsessions. This group is called the forced agitations, which are divided into the mental agitations, relating to interrogation, hesitation, deliberation, precision, symbolism, calculation, research, perfection, infinity, compensation, day dreams and feelings relative to time, such as the past and future. The motor agitations are the tics and the emotional agitations which comprise the states of anxiety, the phobias and algias. The tics are the *diffuse* motor agitations, the phobias and algias belong to the same group, but are more systematized. All the phobias have a disagreeable character, a certain vague, yet deeply rooted fear, while the algias, on the contrary, actually give a suffering of somatic pain in the performance of certain daily acts. Both of these have fundamental and common characteristics, they are developed as the result of sensations excited in certain parts of the body; probably in a region already hyperæsthetic. The states of anxiety are studied both from the standpoint of psychological analysis and the accompanying physiological phenomena, such as cardiac disorders, disorders of the respiration and intestinal tract, vertigo, various paræsthesias, nocturnal terrors and profuse perspiration. The crises of these forced agitations always begin at the occasion of a voluntary act, and with these are associated profound disorders of attention and varying emotional states. Conscience always remains clear during the crisis, but there is an irresistibility to the agitations and a feeling of satisfaction in their accomplishment. If there should arise a feeling of resistance, there always accompanies this more or less acute mental or physical pain until the act is accomplished.

The stigmata of these psychasthenic states are next studied and given minute analysis. These diverse stigmata are the sense of incompleteness in the motor, intellectual and perceptual fields, the symptoms of the narrowing of the field of consciousness as in hysteria, namely the anæsthesias, subconscious movements and the hypnotic sleep and finally the disorders of the will, intelligence and emotions. Certain abnormal physiological conditions invariably seem to accompany these phenomena, such as has already been mentioned under the states of anxiety. These multiple phenomena are, according to the author, the result of the "lowering of the psychological tension," just as hysteria was to him "a narrowing of the field of consciousness." In the evolution of the disease processes there are many factors as in all so-called functional disturbances, such as heredity, age, sex and certain physical states and normal conditions. The onset of the disease may also be variable on account of the protean symptomatology, while the course may be either acute, chronic, intermittent or in episodes. The treatment is both suggestive and medicinal and is directed to tonic and sedative medication, waking suggestion, re-education and "relief of the psychological tension."

Les Lois Morbides De L'Association Des Idées, Par M. PELLETIER, Paris, 1904, Jules Rousset.

The first chapter of this book deals in detail with the laws of the

association of ideas in normal states and the author adopts as a working basis the subdivision of resemblance, contiguity, contrast and repetition. The symptoms of mania as then discussed, both as a phase of manic-depressive insanity and as a syndrome in other mental states, such as general paralysis and in certain cases of dementia præcox. Then follows a discussion of the incoherence and flight of ideas in mania. The fifth chapter is devoted to an analysis of the manic phase of eight cases of manic-depressive insanity, according to the conversational method, in order to clearly demonstrate the flight of ideas and the disturbances of association. It appears to us, that for this latter purpose, the test tables of Sommer would be preferable. These disturbances are studied according to a subdivision of sound, contrast, contiguity (either clear or vague), resemblance and repetition. The latter part of the book is devoted to an exposition of the association of ideas in the mentally weak, with experiments on the reaction time. The laws of the association of ideas do not vary in that they are fundamental. Whatever be the mode of psychic activity, the laws of resemblance, of contrast, of contiguity and of systematic association are always at the base. In mental disturbances, and notably in mania and states of mental weakness, the laws are absolutely the same as in normal conditions and act in the same manner. The loss of the higher faculties, the reduction and enfeeblement of attention, the plethora of ideas, are not alone able to explain these symptoms of mania. Both mania and states of mental weakness are the consequence of a very great enfeeblement of the psychic processes. The enfeeblement is not supreme, the thinking processes are the same as in normal states, only they are more defective. Psychological analysis shows that this enfeeblement is in the state of consciousness itself, and a simple difference of force modifies the course of the state of consciousness, in such a way that the result is either a cohesion of language or the extreme incoherence of mania.

Recherches sur la Structure de la Partie Fibrillaire de Cellules Nerveuses a L'État Normal et Pathologique. Par G. MARINESCO. Revue Neurologique, 15 Mar., 1904.

This paper is an exhaustive study of the neuro-fibrillar structure of nerve cells, as revealed by the new method of Ramon y Cajal, namely, treatment of the tissue with silver nitrate and reduction with pyrogallic acid or hydroquinon. There are twenty-five illustrations, which show in an excellent manner, the distribution of the neuro-fibrils within the cell body, in both normal and pathological states. After treatment by the method detailed, the motor cells of the cord are of a brownish-red color with a bunching together of the fibrils into a net-work which takes the same color. This net-work is best seen and is most complete in the cords of newly born rabbits. In the base of the cone of origin the neuro-fibrils diverge and spread out in a fan-like manner; they then come together and form filaments which lose their fibrillary appearance. In the motor cells, the net-work of neuro-fibrils is more dense than in the cells of the nuclei of the motor cranial nerves, but even these latter do not present uniformly the same structure. In other cells the fibrils form a dense network around the nucleus. The direction and disposition of the fibrils follow the form and volume of the cell, but in fusiform, oblong and triangular cells, the fibrils traverse the cells without forming a network. The individual neuro fibrils have not the same uniform dimensions, and in the triangular and oblong cells they have a fasciculated or striated appearance. Marinesco distinguishes two classes of network; the superficial or perisomatic, and the deep or peri-nuclear, and these latter

again have primary filaments which follow a long course in the cytoplasm and secondary short filaments which take a transverse direction. Some of the long fibrils have a serpentine arrangement. In experimental anæmia and rabies and also in secondary lesions after injury of the peripheral nerves, the fibrils diminish in number, become of a pale diffuse brownish color with a fine granular appearance, or may show fusiform thickenings along their course. These pathological appearances vary according to the intensity of the injury or toxine, or the duration of any of the abnormal conditions.

The Psychological Bulletin. (Literary Section of the Psychological Review, June 15, 1904.)

This number of the Psychological Bulletin is a happy innovation, it is entirely devoted to psychiatry and neurology and is produced under the editorship of Dr. Adolf Meyer, who writes the first paper in the number, devoted to the exposition of modern clinical psychiatry, especially as exemplified by the evolution of the recent German schools, under the leadership of Kraeplin, Wernicke and Ziehen. The second paper is a review by Dr. August Hoch of psychological and physiological tests made in connection with the study of various mental diseases, both from the standpoint of research and diagnosis. The review of psychological literature that follows consists mainly of abstracts of recent important books and papers bearing on neurology and psychiatry. Among these are the recent volumes by Bethe and Nisal on the anatomy of the nervous system, the Archives of Neurology of the London County Asylums, and finally minute abstracts of Bleuler's case of one-sided occupation delirium in a general paralytic, and Liepmann's remarkable case of one-sided apraxia, which has recently come to autopsy. The other reviews relate principally to current German, French and Spanish literature and comprise such contributions as Köster, Saint-Paul, Berze, Klippel, Ramon y Cajal and Dejerine.

Der tic, sein wesen und seine Behandlung. Nebst eine vorrede von PROFESSOR BRISSAUD. DR. HENRY MEIGE und DR. E. FEINDEL. Deutsche Autorisierte Ausgabe von Dr. O. Giese. pp. i-xii, 1-398. Leipzig und Wien, 1903.

The mental and motor disturbance designated by the title of this book has long been of considerable interest to psychiatrists and practicing physicians. But its general characteristics, and especially the conditions and factors in its development should be of equal interest to the student of general psychology. The authors have been for a number of years special students of their subject, and have not only a thorough acquaintance with the work of their predecessors, but have themselves contributed more to it than any other two workers in the field.

Their object in the present book is (1) to present clinical material that is itself of interest, and (2) to differentiate clearly tic from the numerous other forms of motor disturbance. The scope of their data and discussions, however, is wider than this statement of their purpose. The clinical material is presented in the form of copious illustrations taken from the histories of cases. To this attaches, in the reviewer's judgment, fully half the interest and value of the book, but it cannot be presented in a brief review. A history of a case, the "prototype of a tic patient," constitutes an introductory chapter and gives a general picture of the characteristics of tic.

The following chapter outlines the results of predecessors. The

main deficiency in previous and current conceptions of tic lies in the misunderstanding of the relation of its motor and mental aspects. It is a psycho-motor phenomenon, but has been regarded as entirely psychic or entirely motor alone. Again, some who have not overlooked the motor aspect have included other motor processes, or have limited tic to its clonic form, excluding the tonic contractions that have all the other characteristics of it.

The nature of the motor process in tic is described in several following sections in connection with other motor processes, a special comparison being made between tic and spasm The authors recognize two main forms of motor reactions. (1) The simple spinal reflex, with no co-ordination, and no systematic function. In the origin of this the will has no part, and can but seldom repress it. (2) The functional movements. These are co-ordinated, purposive movements, more or less automatically performed. Here belong (a) the movements of the vegetative functions, circulation, digestion, etc. (b) Movements that co-ordinate definite functions from birth onward in the origin of which the will does not participate, but over which it may develop an influence, *e. g.*, breathing, sucking, etc. (c) Movements which arrive at a complete co-ordination only after more or less learning, *e. g.*, walking, chewing (d) Movements which originally attach themselves to ideas, but which through practice also develop the automatic character of the functional activity. Implicitly, the movement performed with voluntarily directed effort would constitute an intermediate class. The spinal or bulbular reflex movement is a spasm, if its stimulus has a pathological cause. Tic belongs to the second group, that of the functional movements. The functional movement involving voluntary muscles is a tic, if the motor reaction shows quite definite pathological signs.

The nature of the mental characteristics in tic are described mainly in connection with the consideration of the origin of the pathological motor process. Tic may take its origin in an external stimulus, in imitation, or in a centrally aroused idea. There may be the desire to avoid an unpleasant stimulus and hence the consequent movements, *e. g.*, turning of head to the side because of a rough-edged collar, winking because of dust particle under the eye-lid. Or there may be the desire to reproduce a certain stimulus, *e. g.*, pulling of a joint in order to hear it snap A striking attitude or performance of another may be imitated because of its peculiarity. Finally, the idea of a certain movement and the impulse to perform it may be a pure product of the imagination. In any of these cases, and the special instances under each are varied and numerous, repetition makes the movement habitual. The original peripheral stimulus or centrally aroused idea is absent, but the performance of the movement continues without occasion or purpose, as an habitual automatic activity. In the development of this condition of the now pathological motor process a deficient will power is an essential and fundamental element. The tic patient has a weak will, and with it may go other traits characteristic of a partially arrested mental development. The development of the pathological phenomenon takes its own course because there is not the ability of voluntary resistance. This is one of the main things that distinguishes tic from the habitual, stereotyped performance of the normal person. The tic patient cannot check his habit, and further, he suffers through its repression. Also, the habitual movement of the normal person occurs unawares, when his attention is engaged in something else. Tic occurs when the mind and body are unoccupied. It weakens or disappears when the attention of the patient is directed to some other activity.

The localization of the tic is various. Any muscle of the body may be involved. The only rule to be noted is that those muscles that are used most, or are most expressive of mental states are most frequently the seat of this pathological activity. A single muscle alone is never involved, but only such groups as are used in co-ordinated functional movements. The authors devote a section to the description of different tics, naming them according to both the group of muscles involved, and the function of those muscles, such as the facial tics, or the mimetic tics, the lip tics, or the sucking tics, etc. Copious illustrations are given as usual. The form of the motor process may be that of either the clonic or tonic contraction. Other authors have not included the latter, but there are tonic contractions that have associated with them all the other characteristics of tic. There is no regular rhythm or frequency in the occurrence of the movements. They make their first appearance most frequently during childhood, but may begin at any other time of life, and usually continue up to old age. Several sections are devoted to the relation of tic to other diseases, differential diagnosis, other symptoms associated with tic, etc., that are of interest more to the clinician than to the psychologist.

The general outcome of these considerations is that tic is a unique psycho-motor phenomenon that may have various symptoms of other nervous disorders associated with it, but it bears no necessary relation to these. As to the etiology of tic nothing very definite is ventured. A variety of things may be the initiating occasion of what will later develop into a tic, but these cannot be regarded as causes. After these have been enumerated, the authors conclude that the psychic predisposition of the individual remains the *conditio sine qua non* for the origin and development of tic. The previous statement in regard to the weak will power, and partially arrested development of the tic patient is of course to be remembered in this connection. Some anatomical changes have been reported, but these the authors regard, not as characteristic of tic, but as results of complications of the cases reported. They regard tic as an inherited functional anomaly associated with a deficient development of cortical association tracts, or sub-cortical branchings, with molecular malformations that cannot be detected by present methods.

The last sixty pages of the book are devoted to a consideration of the treatment of tic. The degree of curability is, in general, dependent upon the degree of will power of the patient. Medicinal treatment is of little value. The rules of proper diet, and of general hygiene are to be observed. Proper psycho-motor training is the only direct method that can improve the condition of the tic patient. Two kinds of exercises are to be employed, together. (1) Exercises in remaining absolutely motionless, beginning with short periods that are to be gradually lengthened. (2) Regulated gymnastics, using only correct movements. Special stress is laid upon the use of the mirror. The patient is to perform these exercises also alone in front of a mirror, where he can himself see and correct his anomalies in positions and movements. Such a demonstration of his anomalies is more forceful than description or exhortation.

F. KUHLMANN.

Clark University.

Begaiement et Autres Maladies Fonctionelles de la Parole, by DR. CHERVIN. Société d'Editions Scientifiques. Paris, 1901, pp. 551.

This is a revised and enlarged edition of the author's former work. The book is divided into four parts and an appendix. In part I he discusses the rôle of speech in society and classifies speech defects according to their causes. In part II he takes up stuttering proper giv-

ing first a brief history of stuttering and then the etymology of the word "stutter," tracing it through many languages and dialects. This is followed by a valuable chapter on statistics, based on the military statistics on stuttering and other nervous diseases in France, Switzerland, England, Austro-Hungary, Belgium, Italy and Russia, and presents ethnographic maps of all of these countries except England, showing the distribution of the troubles in question. In the next chapter (VI) he takes up the definitions of stuttering, causes, age of appearance, professional stammering, sex, difficulties of respiration, verbal phobias, and hysterical stuttering. When he holds that the ratio of male to female stutterers is 10:1 he deals probably with adults. With children the ratio is probably 2:1 or 3:1. He objects to the term *hysterical stuttering* used by many writers, since speech defects due to hysteria, according to him, are not stuttering; he would prefer the term "speech defects of hysteria."

The next four chapters are devoted to methods of treatment. We first have a short history of methods in general, followed by one of the Chervin method. According to the latter method the treatment is divided into two main parts, which, however, are usually carried on together, namely, the functional and mental. The first consists of respiratory and articulatory exercises, and the second part in insisting vigorously that the patient carefully imitate the instructor. The length of the course is three weeks. During the first week the patient is taught the elements of speech and methods of breathing, and he must keep absolute silence outside of instruction hours. During the second week the principles of respiration and articulation are further practiced, the patient is given liberty of speech, but must speak slowly and methodically. During the third week attention is given to phrases and to inflection of the voice, gradually coming to natural diction and ordinary conversation. When, at the end of three weeks, the patient is dismissed, he is considered only convalescent; he should practice his exercises from 2-3 hours a day for at least a month. The last chapter of part II is devoted to a discussion of the question of military exemption on account of stuttering.

Part III deals with various other functional speech defects. It is divided into four chapters. In the first he discusses various forms of stammering *(blésité)* and says the sex ratio is the inverse of that in stuttering. In the next chapters he takes up rhotacism—faulty pronunciation of the letter *r*, the eunuch voice and nasalizing. Faulty articulation he cures by an orthophonic treatment. If nasalizing, however, is due to organic causes a surgical operation should precede the didactic treatment.

In part IV the author deals with speech defects due to organic causes, such as hare-lips and cleft palates.

In the appendices the first eighty-nine pages are devoted to some old traditions and some collections from folklore relative to speech and speech defects; and finally the last sixty-two pages are given to reports from official commissions, medical and scientific societies, setting forth the merits of the Chervin method—advertising material which should not have been made an integral part of the book.

In a book coming from a physician and teacher of such experience, one is disappointed not to find more clinical data. The anthropological portion of the book is very good and the extensive statistics should be helpful. The book is written in a clear and concise style, and in spite of its defects is one of the best works on the subject which it treats.

EDWARD CONRADI.

Clark University.

SUBJECT INDEX.

Action, 462. See also Will.
Advertising, theory of, 118.
Æsthetics, 117; Hirn's "Origin of Art," 457; music, 456; theoretical, 456, 457. See also Dancing.
Anthropology, 460. Aboriginal American Basketry, 312. Archæology, methods and aims of, 452. *Archiv für Rassen- und Gesellschafts-Biologie*, 312. Comparative (ethnological) psychiatry, 587. Culture problems of the present, 312. Ethnic factors in South America, 311. Ethnology, 116, 311, 460. Food of Klamath Indians, 462. Homes of the Indo-Germans, 450. Japanese, evolution of, 462, society, 449. Macedonian folklore, 451. Malay magic, 311. Right of Asylum among primitive peoples, 452. Symbolism, 454. Travels and observations: Central Africa, 450; China, past and present, 450; Cochinchina and Combodia, 450; Colony of Sierra Leone, 450; Great Benin, its customs, art and horrors, 451; India, past and present, 450; Kamchatkan experiences, 449; Land of the Dons, 451; Lhasa and Central Tibet, 311; Polynesia, 311; Syria and Palestine of to-day, 452; Women in Java, 450.
Apparatus, 57; Whipple gasometer, 57; Frame for adaptation and after-images, 57; Contrast frame, 58; Six-fold color-mixer, 58; Wall campimeter, 59; Disc cutter; 59; Simple complication pendulum, 581.
Association: Association of ideas in the insane, 590. See also Memory.
Attention fluctuations, effect of closing the eye on, 512.
Audition: Auditory tests, 14; speech tests, 26; tests with mechanical sounds, 42; tests of tonal limits, 46. See also Beats and Tonal sensations.

Beats, Ebbinghaus' explanation of, 62; phenomena of, 66; Stumpf's explanation of, 67.
Biological: Development, experimentally controlled, 454. Immunity and susceptibility of fertilized sea-urchin eggs, 462. Polydactylism in man and domestic animals, 118. Psychic phenomena, origin and biological signification of, 120. Segmentation, special physics of, 454. See also Comparative Psychology, Evolution, Heredity, Philosophical.

Children, tests of, 201. Day-dreaming of, 465.
Color-mixing, apparatus for, 58, disc cutter, 59.
Comparative psychology, 313; Association in hermit crabs, 462; Animal Education, 115; Bees, 456; English sparrows, 313; White rats, 115.
Contrast, apparatus for, 58.
Corrections, 120, 312.
Correlation, 72, 201; Methods of determining, 77.
Criminal responsibility and degeneracy, 463.

Dancing, history of, 462.
Degeneracy and the degenerate, 454, and criminal responsibility, 463.
Day dreams, psychology of, 465; Morbid, 483; Age in relation to, 469.

Emotions, 569.
Ergograph as a measurer of work capacity, 307.
Errors of observation, 462.
Ethics, 115, 458; social ethics, 457.

Evolution, and adaptation, 119. Descent of man, 462. Direction of Hair in animals and man, 455. Natural selection, 454. Origin of the bee community, 456.
Experimental psychology, 202, 462; in Italy, 515. First German Congress for Experimental Psychology, 447. German Society for Experimental Psychology, 464. Methods and standpoint of psycho-physics, 455. See also, Correlation, Ergograph, Tests.

Fatigue curves in sane, neurotic and insane, 587.
Feeling and attitude of consciousness, 120.

General Intelligence, 201.

Hemianopic hallucinations, 586.
Hypnotism, 117.
Heredity, 462, 463; and social progress, 113.

Ideas, 305.
Idiocy, see Mental deficiency.
Imagination and day dreaming, 481.
Imitation, 456.
Inhibition, 453, 532.

Language, defects of: Stuttering, 594.
Logic, 308, 462; logical theory, 117.

Memory, 7, 462. Memory and association in sane and insane, 585.
Mental deficiency, 391.
Mental imagery, 480.
Mental tests, 15, 489; literature of, 20.
Mind and body, 302; Prof. Strong on, 119.
Miscellaneous: Astrophysics, 462. Count de Gobineau and aryanism, 449. Diary of a Turk, 451. Identification of pure organic compounds, 461. Infectious diseases, 452. Limits of history, 461. St. Louis Congress of Arts and Science, 463.
Movement, 117. Daily variation in motor ability, 460.

Nervous diseases, 311; nervous and mental diseases, 452. Central nervous system in alcoholic paralysis, 586. Pathological changes in the medulla in acute diphtheritic toxæmia, 586. Tabes, 584. Tic, 592.
Neurology, recent progress in, 116. Brain anatomy and psychology, 453. Excitation, inhibition and narkosis, 453. Fibrillar structure of nerve cells in normal and pathological conditions, 591. Nerve chemistry, 585. Neurones and the neuron concept, 453. Summation, 540.

Pain, quantitative studies of, 462.
Philosophical. Fundamental problems of philosophy, 116; American Philosophical Association, 310. Animate and inanimate nature, 453. Bain's philosophical essays, 116. Balance, the fundamental verity, 457. Beneke's metaphysics, 459. Categories, 459. Comte, 117. Crystallization and morphogenesis, 453. Descartes, Spinoza and the new philosophy, 459. Energy, entropy and proof of a creator, 115. Hobbes, 120. Idealistic argument against materialism, 458. Lao-tze's Tao-teh King, 117. Life in the universe, 455. Living and non living matter, 453. Limits of the cognizable, 115. Man's place in the cosmos, 461. Monism in Italy, 459. Nature of man (essays in optimistic philosophy), 117. Neo-Platonism, 458. Philosophy in America, 438, of pure experience, 310. Philosophy of the present day, 459. Reality, 460. St. Anselm, translation of certain of his works, 116. Second International Congress of Philosophy, 463. Spiritual currents of the present, 460. *The Edwardean*, 116.

Physiological: Circulation and cerebral action, 499. *Fortschritte der Physiologie*, 462. Muscular tonus, 547. Nature of vital phenomena, 460. Periodicities of the human organism, 309. Traube-Hering waves, 499. Vascular tonus, 544. Wellcome Physiological Research Laboratories, 116. See also Inhibition, Neurology and Reflex action.

Psychiatry, 452, 582. Amentia and dementia, 585. Comparative psychiatry, 587 Dementia præcox, 463. Juvenile general paralysis, 585. Moral insanity, 586. Obsessions and psychasthenia, 589. Research in state hospitals for insane, 118. Traumatic insanity, 582.

Practice and learning, 307.

Psychic Research, 461.

Psychosis, subjective and objective aspects of, 2.

Psychologists, Cattell's statistics of, 102.

Psychological Journals and Serials. *L'Année psychologique* Vol. VIII, 118, Vol. X, 448. *British Journal of Psychology*, 294 *Journal of Philosophy, Psychology and Scientific Method*, 461 *Psychological Bulletin*, 462, 592. *University of Colorado Studies.*

Psychological Textbooks and General Works. Lipps's Leitfaden der Psychologie, 462. Münsterberg's Grundzüge der Psychologie, Pt. I, 295. Natorp's Allgemeine Psychologie, 455. Wundt's Grundzüge der physiologischen Psychologie, 5th Ed., 116, 361

Psychology: and brain anatomy, 453; structural and functional, 118. See also Soul.

Psychophysics, see Experimental Psychology.

Reaction time and movement, 462; as a mental test, 489.

Recognition and comparison, 305.

Reflex action, history of, 526. Direction of transmission and co-ordination of reflexes, 554 Tendon reflexes, 551. Reflexes, speculative considerations on, 561.

Religion, Höffding's theory of, 108 Christ, unwritten sayings of, 115. Virgin Birth of, 114 Immortality and destiny, 120. Religion and science, 120. Theological and philosophical literature, 118.

Sex, 104. Sex and love of children, 460. Nocturnal Emissions, 104.

Social Psychology. Anarchistic individualism, 457. Family, 457. Immigration and population, 118.

Soul, history of ideas of the, 121. Primitive ideas of, 122 Greek ideas of, 153. Theological ideas of, 164. Philosophical ideas of, 185. Psychological theories of, 347. Current popular ideas of, 359. Ideas of materialists regarding, 373. Ideas of the "Self," 375. Seat of the Soul, 378.

Test of discriminative power (by weights), 245; of hearing, 243. Tests of visual brightness, 244.

Time-perception, theory of, 1; measurement of, 1. Duration and succession, 4. Origin of time-perception, 9. Rhythmic character of consciousness, 5. "Specious present," 1. "Time dragging" and "time flying," 4.

Tonal sensations, Helmholtz' theory of, 62. Upper and lower limits, 46.

Vision, 456. Adaptation, apparatus for, 57. After-images, apparatus for, 57. "Facial Vision," 383.

Voluntary muscular contraction, 460,

Will, freedom of, 115, 116.

NAMES OF AUTHORS.

(The names of those who have contributed original matter are printed in SMALL CAPITALS.)

Abbott, G. F., 451.
Aikins, H. Austin, 308.
Alsberg, Moritz, 462.
ANDREWS, BENJAMIN RICHARD, 14.
Angell, James Rowland, 118
ARNETT, L. D., 121, 347.

Bain, Alexander, 116.
BAIRD, J. W., 113, 295.
Barthélemy, Marquis de, 450.
Basch, Victor, 457.
Baumann, J., 459.
Beaunis, H., 448.
van Becelaere, L., 458.
Beck, P., 456.
Bellessort, André, 449.
Benedikt, Moriz, 453.
BENTLEY, I. MADISON, 62, 102, 302.
Bergemann, Paul, 458.
Binet, Alfred, 118, 448.
Bolton, Joseph S., 585, 586.
Bolton, T. L., 307.
Bose, Jagadis Chunder, 453.
Bramwell, J. Milne, 117.
Breukink, —, 587.
Brissaud, —, 592.
von Buttel-Reepen, H., 456.

Calkins, M. W., 305.
Carus, Paul, 117.
Cels, Alphonse, 460.
Chervin, —, 594.
CHIABRA, GIOVANNI, 515.
Church, Archibald, 452.
Clerke, Agnes M., 462.
Coillard, François, 450.
Cole, —, 586.
CONRADI, EDWARD, 594.
CORIAT, I. H., 582.
Coutagne, Georges, 462.
Coville, Frederick Vernon, 462.
Crooks, J. J., 450.
Curtis, William E., 452.
Czuber, Emanuel, 462.

Dantec, Félix Le, 115.
Das, Sarat Chandra, 311.
Dean, Sidney Norton, 116.
Dewey, John, 117.
Downes, Robert P., 120.
Dowson, Walter, 116.
Driesmans, Heinrich, 312.

Edinger, L., 453.
Eucken, Rudolf, 460.

Fiendel, E. 592.
Fite, Warner, 115.
Forbes-Lindsay, C. H., 450.
FRENCH, F. C., 108.

GALLOWAY, C. E., 499.
GAMBLE, E. A. McC., 305.
GAULT, ROBERT H., 526.
Giese, O., 592.
Gottl, F., 461.
Grego, Joseph, 462.
Griffinhoofe, C. G., 115.
Gulick, Sidney L., 462.

Haldane, Richard Burdon, 460.
Halid, Halil, 451.
Halliburton, —, 585.
Harrison, Frederic, 117.
Hektoen, Ludvig, 452.
Hellwig, A., 452.
Henri, V., 448.
Hermann, L., 462.
Hirn, Yrjö, 457.
Hoch, A., 587.
Höffding, H., 108.
Hulbert, Homer B., 449.

Iotekyo, J., 462.
Iverach, James, 459.

Janet, Pierre, 589.
Johnson, William Hallock, 116.
JONES, ADAM LEROY, 309.
Jordan, Edwin O., 452.

Kalberlah, —, 582.
Keller, Albert Galloway, 116.
Kidd, Walter, 455.
KILLEN, BERTHA, 512.
Kraepelin, F., 587.
Kronenberg, M., 459.
Kuczynski, R., 118.
KUHLMANN, F., 307, 391, 592.

Langdon, F. W., 116.
Larguier des Bancels, J., 462.
Laurilla, K. S., 457.
Leuliette, Victor, 114.
Levy-Bruhl, L., 117.
Ling Roth, H., 451.

Lipps, Theodor, 462.
Lobstein, Paul, 114.

MacDonald, Greville, 120.
MACDOUGALL, ROBERT, 383.
McDougall, W., 294.
Mackintosh, Catherine Winkworth, 450.

Maas, Otto, 454.
Mager, Henri, 311.
Marinesco, G., 591.
Mason, Otis Tufton, 312.
Meige, Henry, 592.
Metchinkoff, Élie, 117.
Meyer, Adolf, 584, 592.
Meyer, E., 582, 583.
Miller, Eleanora T., 307.
Mills, Wesley, 453.
Mitchell, P. Chalmers, 117.
Möbius, P. J., 460.
MONTAGUE, W. P., 1.
Moore, Thomas V., 462.
Morgan, Thomas Hunt, 119.
Morrison, W. D., 114.
Morselli, Enrico, 459.
Mott, F. W., 584.
Much, Matthaeus, 450.
Müller, G. E. 455.
Mulliken, Samuel Parsons, 461.
Münsterberg, Hugo, 295.
Myers, C. S., 294.

Natorp, Paul, 455.
Neumeister, R., 460.
Nuel, J. P., 456.

Orth, Johannes, 120.
Overall, George Whitfield, 120.

Parker, Edward H., 450.
Patten, Simon N., 113.
Pearce, F. Savary, 311.
Pelletier, —, 590.
Peterson, F., 452.
Petrie, W. M. Flinders, 452.
Petzoldt, Joseph, 310.
Pick, A., 586.
Pilcz, Alexander, 452.
PILLSBURY, W. B., 312, 499.
Plate, Ludwig, 454.
Ploetz, Alfred, 312.
PORTER, JAMES P., 313.
Powell, J. W., 460.
Prentiss, C. W., 118.
Prince, Morton, 119.
Pringle-Pattison, A. Seth, 461.

Raecke, —, 583.
Raymond, F., 589.
Ribot, Th., 448.
Riehl, Alois, 459.
Riehl, W. H., 457.
Riemann, Hugo, 456.
Rivers, W. H. R., 294.
Roeder, Adolph, 454.
Royce, Josiah, 310.
Rutot, M. A., 462.

Salmond, S. D. F., 118.
Samfiresco, Elvire, 117.
Schweitzer, R., 115.
Scott, Walter Dill, 118.
Seillière, Ernest, 449.
Seitz, Anton, 115.
Sergi, G., 120.
Shaler, N. S., 457.
Shand, A. F., 294.
Sherrington, C. S., 294.
Skeat, Walter William, 311.
Smith, Orlando J., 457.
SMITH, THEODATE L., 465.
Smith, W. G., 294.
Smith, —, 585.
Spaulding, E. G., 454, 462.
SPEARMAN, C., 72, 201, 447.
SPILLER, GUSTAV, 569.
Squeres, Wm. H., 116.
Stedman, H. R., 586.
Stefanowska, M., 462.
Stern, Paul, 116.
STEVENS, H. C., 515, 581.
Stirling, James Hutchinson, 459.
Storey, Thomas Andrew, 460.
Stratz, C. H., 450.
Strong, C. A., 302.
Swoboda, Harmann, 309.

TITCHENER, E. B., 57, 62.
Tredgold, A. F., 585.

Vanderlip, Washington B., 449.
Viedenz, —, 582.

Walton, G. L., 454.
Wandschneider, Albrecht, 459.
Ward, James, 294.
Wartenberg, M., 458.
Watson, George A., 585.
Watson, John B., 115.
Wedensky, N. E., 453.
Wernick, G. 117.
Wherry, J. W., 118.
WHIPPLE, GUY MONTROSE, 489.
Whittaker, Thomas, 458.
Williams, Leonard, 451.
Williams, Talcott, 311.
Witasek, Stephan, 456.
Woodbridge, Frederick J. E., 120.
Woodworth, R. S., 117.
Wundt, Wilhelm, 116, 461.

Zehnder, Ludwig, 455.